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SITE-SPECIFIC TECHNICAL REPORT FOR FREE PRODUCT RECOVERY TESTING AT SITE FT-002, PLATTSBURGH AFB, NEW YORK

DRAFT

PREPARED FOR:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
TECHNOLOGY TRANSFER DIVISION
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21 APRIL 1997

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SITE-SPECIFIC TECHNICAL REPORT (A003)

for

FREE PRODUCT RECOVERY TESTING AT SITE FT-002, PLATTSBURGH AFB, NEW YORK

by

A. Leeson, M. Place, and L. Cumming

for

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21 April 1997

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

This report summarizes the field activities conducted at Plattsburgh Air Force Base (AFB) for a short-term field pilot test to compare vacuum-enhanced free-product recovery (bioslurping) to traditional free-product recovery techniques used to remove light, nonaqueous-phase liquid (LNAPL) from subsurface soils and aquifers. The field testing at Plattsburgh AFB is part of the Bioslurper Initiative, which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division. The AFCEE Bioslurper initiative is a multisite program designed to evaluate the efficacy of the bioslurping technology for (1) recovery of LNAPL from groundwater and the capillary fringe, and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

The main objective of the Bioslurper Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate bioslurping and identify site parameters that are reliable predictors of bioslurping performance. To measure LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The test at Plattsburgh is one of more than 40 similar field tests to be conducted at various locations throughout the United States and its possessions.

The intent of field testing is to collect data to support determination of the predictability of LNAPL recovery and to evaluate the applicability, cost, and performance of the bioslurping technology for removal of free product and remediation of the contaminated area. The on-site testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with the performance of more conventional LNAPL recovery technologies. The test method included an initial site characterization followed by LNAPL recovery testing. The three LNAPL recovery technologies tested at Plattsburgh AFB were skimmer pumping, bioslurping, and drawdown pumping.

Bioslurper pilot test activities were conducted at monitoring well MW-108. Site characterization activities were conducted to evaluate site variables that could affect LNAPL recovery efficiency and to determine the bioventing potential of the site. Testing included baildown testing to evaluate the mobility of LNAPL, soil sampling to determine physical/chemical site characteristics, soil gas permeability testing to determine the radius of influence, and in situ respiration testing to evaluate site microbial activity.

Following the site characterization activities, the pump tests were conducted. At monitoring well MW-108, pilot tests for skimmer pumping, bioslurping, and drawdown pumping were conducted. The LNAPL recovery testing was conducted in the following sequence at monitoring well MW-108: 44 hr in the skimmer configuration (a 5 hr shutdown occurred during testing), 97 hr in the bioslurper configuration, an additional 19 hr in the skimmer configuration, and 23 hr in the drawdown configuration.

Measurements of extracted soil gas composition, LNAPL thickness, and groundwater level were taken throughout the testing. The volume of LNAPL recovered and groundwater extracted were quantified over time.

Baildown recovery tests were conducted at monitoring wells H196S and MW-108. Baildown recovery tests provide a qualitative indication of the presence of mobile, free-phase LNAPL and recovery potential. Overall, the baildown recovery tests indicated a relatively rapid rate of LNAPL recovery into the wells. At monitoring well MW-108, LNAPL recovered to initial levels by the end of the 17 hr baildown test. At the extraction well, LNAPL recovered to a level approximately 87% of the initial LNAPL thickness. Based on these results, pilot testing was initiated on monitoring well MW-108.

Direct pumping tests were conducted at monitoring well MW-108. Skimmer pump testing was conducted at monitoring well MW-108 mode for approximately two days. A small quantity of LNAPL was recovered during this test during 44 hr of extraction. LNAPL could not be quantified until the end of the pump test due to the small quantity extracted; therefore, only the average rate over the entire test could be calculated. The average LNAPL recovery rate was 7.7 gallons/day, with a total of 14 gallons of LNAPL recovered. A total of approximately 1,905 gallons of groundwater was produced with an average production rate of 990 gallons/day. LNAPL recovery rates increased substantially during the bioslurper pump test. Bioslurper testing was conducted for approximately four days, with the LNAPL recovery remaining relatively constant throughout testing, with an average LNAPL recovery rate of 41 gallons/day. A total of 165.3 gallons of LNAPL and 8,678 gallons of groundwater was extracted, with a daily average groundwater production rate of 2,200 gallons/day. The LNAPL recovery rate was higher during the second skimmer pump test than that observed during the initial skimmer pump test, perhaps due to increased LNAPL mobility due to the bioslurper pump test. Approximately 16.3 gallons of LNAPL and 680 gallons of groundwater were recovered during the second skimmer pump test, with daily average recovery rates of 21 and 870 gallons/day, respectively. These results demonstrate that operation of the bioslurper system in the skimmer mode was an effective means of free-product recovery, although recovery is less than that observed during bioslurping.

Drawdown pump testing was conducted to determine if a cone of groundwater depression would enhance LNAPL recovery. The water table was depressed 18 inches below the static water table in monitoring well MW-108. Less LNAPL but more groundwater was recovered during this test than during the skimmer pump tests. LNAPL and groundwater recovery rates were on the order of 13 and 1,800 gallons/day, respectively. These results demonstrate that the vacuum gradient maintained during the bioslurper test resulted in higher fluid recovery rates than the 18 inch-groundwater drawdown test.

Bioslurping also promotes mass removal in the form of in situ biodegradation via bioventing and soil gas extraction. Vapor phase mass removal is the result of soil gas extraction as well as volatilization that occurs during the movement of LNAPL free product through the extraction network. All extracted soil gas was treated with the Thermatrix®. Given a vapor flowrate of 14 scfm and using an average concentration of 47,000 ppmv TPH and 66 ppmv benzene, approximately 190 lb/day of TPH and 0.26 lb/day of benzene were removed in the vapor phase. Thus, mass removal in the vapor phase is significant. Higher vapor mass removal rates are more often sustained at those sites where liquid product recovery is sustained.

The initial soil gas profiles at the site displayed oxygen-deficient, carbon dioxide-rich, high total volatile hydrocarbon vapor conditions. These conditions indicate that natural biodegradation of residual petroleum hydrocarbons has occurred, but is limited by oxygen availability. Soil gas concentrations were measured during the bioslurper test at monitoring points adjacent to monitoring well MW-108 to determine if the vadose zone was being oxygenated via the bioslurper action. Soil gas concentrations were measured during the bioslurper test at monitoring points adjacent to monitoring well MW-108 to determine if the vadose zone was being oxygenated via the bioslurper action. Oxygen concentrations varied at all monitoring points; however, oxygen levels fluctuated, generally increasing and decreasing with time. This could be the result of pockets of oxygenated and oxygen-limited soil gas passing by the monitoring points. Also, there were trenches in the area which may have influenced soil gas results. Pressure changes were observed up to 50 ft from the bioslurper well and, it is our experience that wherever pressure changes are detected, aeration will occur. Therefore, it is likely that these areas will become aerated over time.

In situ biodegradation rates of 2.8 to 11 mg/kg-day were measured at four different locations. Based on a radius of influence of at least 50 ft and a hydrocarbon-impacted soil thickness of 41 ft, mass removal rates via biodegradation are on the order of 79 to 310 lbs of hydrocarbon per day. Thus, mass removal rates via biodegradation are as significant as the vapor phase removal rates measured during the bioslurper test. These results indicate that bioventing is feasible at this site. Air injection bioventing is preferable over bioslurping and soil vapor extraction with respect to the elimination of hydrocarbon vapor emissions.

In summary, the on-site testing at Site FT-002, Plattsburgh AFB, included the direct testing of gravity-driven and vacuum-driven LNAPL free product recovery techniques, bioventing, physical sampling, and tests relevant to soil vapor extraction. Liquid phase recovery was sustainable under all conditions, but was highest during bioslurping. In addition, bioslurping appeared to increase the flow of LNAPL to the well, as evidenced by increased LNAPL recovery rates during the second skimmer pump test in comparison to the initial skimmer pump test. The in situ respiration test and vadose zone radius of influence testing demonstrate that bioventing may be feasible at this site. Bioslurping appears to be the most suitable recovery technique for this site, providing long-term disposal of extracted water is possible.

DRAFT SITE-SPECIFIC TECHNICAL REPORT (A003)

for

FREE PRODUCT RECOVERY TESTING AT SITE FT-002, PLATTSBURGH AFB, NEW YORK

21 April 1997

1.0 INTRODUCTION

This report describes activities performed and data collected during field tests at Plattsburgh Air Force Base (AFB), New York to compare vacuum-enhanced free-product recovery (bioslurping) to traditional free-product recovery technologies for removal of light, nonaqueous-phase liquid (LNAPL) from subsurface soils and aquifers. The field testing at Plattsburgh AFB is part of the Bioslurper Initiative, which is funded and managed by the U.S. Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division. The AFCEE Bioslurper Initiative is a multisite program designed to evaluate the efficacy of the bioslurping technology for (1) recovery of LNAPL from groundwater and the capillary fringe and (2) enhancing natural in situ degradation of petroleum contaminants in the vadose zone via bioventing.

1.1 Objectives

The main objective of the Bioslurper Initiative is to develop procedures for evaluating the potential for recovering free-phase LNAPL present at petroleum-contaminated sites. The overall study is designed to evaluate bioslurping and identify site parameters that are reliable predictors of bioslurping performance. To measure LNAPL recovery in a wide variety of in situ conditions, tests are being performed at many sites. The test at Plattsburgh AFB is one of more than 40 similar field tests to be conducted at various locations throughout the United States and its possessions. Aspects of the testing program that apply to all sites are described in the Test Plan and Technical Protocol for Bioslurping (Battelle, 1995). Test provisions specific to activities at Plattsburgh AFB are described in the Site-Specific Test Plan provided in Appendix A.

The intent of field testing is to collect data to support determination of the predictability of LNAPL recovery and to evaluate the applicability, cost, and performance of the bioslurping technology for removal of free product and remediation of the contaminated area. The on-site testing is structured to allow direct comparison of the LNAPL recovery achieved by bioslurping with the performance of more conventional LNAPL recovery technologies. The test method included an initial site characterization followed by LNAPL recovery testing. The three LNAPL recovery technologies tested at Plattsburgh AFB were skimmer pumping, bioslurping, and drawdown pumping. The specific test objectives, methods, and results for the Plattsburgh AFB test program are discussed in the following sections.

1.2 Testing Approach

Bioslurper pilot test activities were conducted at monitoring well MW-108. Site characterization activities were conducted to evaluate site variables that could affect LNAPL recovery efficiency and to determine the bioventing potential of the site. Testing included baildown testing to evaluate the mobility of LNAPL, soil sampling to determine physical/chemical site characteristics, soil gas permeability testing to determine the radius of influence, and in situ respiration testing to evaluate site microbial activity.

Following the site characterization activities, the pump tests were conducted. At monitoring well MW-108, pilot tests for skimmer pumping, bioslurping, and drawdown pumping were conducted. The LNAPL recovery testing was conducted in the following sequence at monitoring well MW-108: 44 hr in the skimmer configuration (a 5 hr shutdown occurred during testing), 97 hr in the bioslurper configuration, an additional 19 hr in the skimmer configuration, and 23 hr in the drawdown configuration.

Measurements of extracted soil gas composition, LNAPL thickness, and groundwater level were taken throughout the testing. The volume of LNAPL recovered and groundwater extracted were quantified over time.

2.0 SITE DESCRIPTION

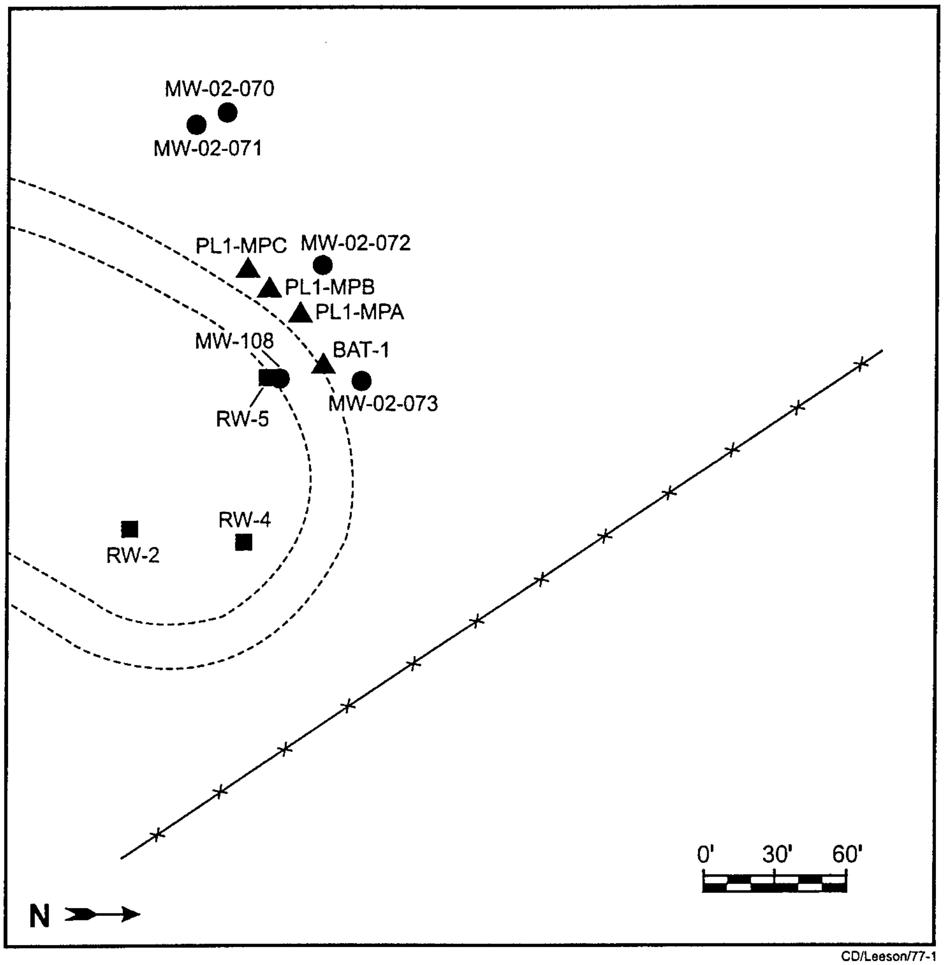
The information presented in this section was obtained from a document entitled *Installation Restoration Program Action Memorandum Fire Training Area 2 (Site FT-002) Plattsburgh AFB, New York*, prepared by Parsons Engineering-Science in April 1996.

Plattsburgh AFB, located in northeastern New York State, adjacent to Lake Champlain, is bordered on the north by the City of Plattsburgh and on the east by Lake Champlain. Plattsburgh AFB was officially closed by the Department of Defense on 30 September 1995 and control of the property transferred to the Plattsburgh Developments Committee.

Site FT-002 is located in the northwest corner of the base and is approximately 700 feet wide and 800 feet long. Site FT-002 was used to train base and municipal fire-fighting personnel from the mid- to late-1950s until the site was permanently closed to standard fire training activities on May 22, 1989. However, limited emergency rescue training had been allowed at the site since 1989 and previous to closure of the base. During fire training exercises, fires were ignited in fire training pits located in the Site FT-002 area. Prior to 1980, the fire pits consisted of sand and gravel depressions. In 1980, cement-stabilized soil liners were added to active Pits 2 and 3. Pits 1 and 4 had been previously removed from service.

Four distinct stratigraphic units underlie Site FT-002: sand, clay, till, and carbonate bedrock. The sand unit generally extends from ground surface up to 90 feet bgs in the vicinity of Site FT-002. A 7-ft-thick clay unit has been identified on the eastern side of the site. The thickness of the clay on the western side of the site has not been determined. A 30- to 40-ft thick clay/till unit is also present from 80 to 105 ft bgs in the vicinity of Site FT-002. Bedrock is located approximately 120 ft bgs. Groundwater occurs in the sand unit approximately 30 to 40 ft bgs.

The results of previous investigations suggest that the soil and groundwater associated with and downgradient of the fire training area is contaminated with JP 4 jet fuel-related compounds and chlorinated solvents. The unburned fuel mixture seeped beneath the pits and, over years of training exercises, contaminated the soil column and groundwater underlying the pit area. In some areas, the soil is saturated with fuel. LNAPL is present in the capillary fringe and floating on top of the groundwater in some areas. The former fuel storage tank and oil/water separator that served Pits 2 and 3 have also been identified as potential sources of soil and groundwater contamination. Figure 1 illustrates locations of groundwater monitoring wells.



▲ Monitoring point
● Monitoring well

Figure 1. **Schematic Diagram Illustrating Groundwater Monitoring Well and Monitoring Point Locations at Site FT-002**

3.0 BIOSLURPER SHORT-TERM PILOT TEST METHODS

This section documents the initial conditions at the test site and describes the test equipment and methods used for the short-term pilot test at Plattsburgh AFB.

3.1 Initial LNAPL/Groundwater Measurements and Baildown Testing

Monitoring wells MW-108 and an extraction well approximately 15 ft south of monitoring well MW-108 were evaluated for use in the bioslurper pilot testing. Initial depths to LNAPL and to groundwater were measured using an oil/water interface probe (ORS Model #1068013). LNAPL was removed from the well with a Teflon® bailer until the LNAPL thickness could no longer be reduced. The rate of increase in the thickness of the floating LNAPL layer was monitored using the oil/water interface probe for approximately 16 hr at the extraction well and for approximately 17 hr at monitoring well MW-108.

3.2 Well Construction Details

Short-term pump tests were conducted at monitoring well MW-108. Monitoring well MW-108 is constructed of 2-inch-diameter, schedule 40 polyvinyl chloride (PVC). Construction details for monitoring well MW-108 have not been received from the Base. A schematic diagram illustrating general well construction details for monitoring well MW-108 is provided in Figure 2.

3.3 Soil Gas Monitoring Point Installation

One monitoring point was installed and labeled BAT-1. Existing monitoring points also were used, labeled MPA, MPB, and MPC. The locations and general constructions details of the monitoring points are illustrated in Figures 1 and 2.

At monitoring point BAT-1, the monitoring point consisted of ¼-inch tubing, with 1-inch-diameter, 6-inch-long screened areas. The screened lengths were positioned at depths of 12, 18.5, and 25.5 ft bgl. The annular space corresponding to the screened length was filled with silica sand. The interval from the top of the screened length to the bottom of the next screened length, as well as the interval from the ground surface to the top of the first screened length, was filled with

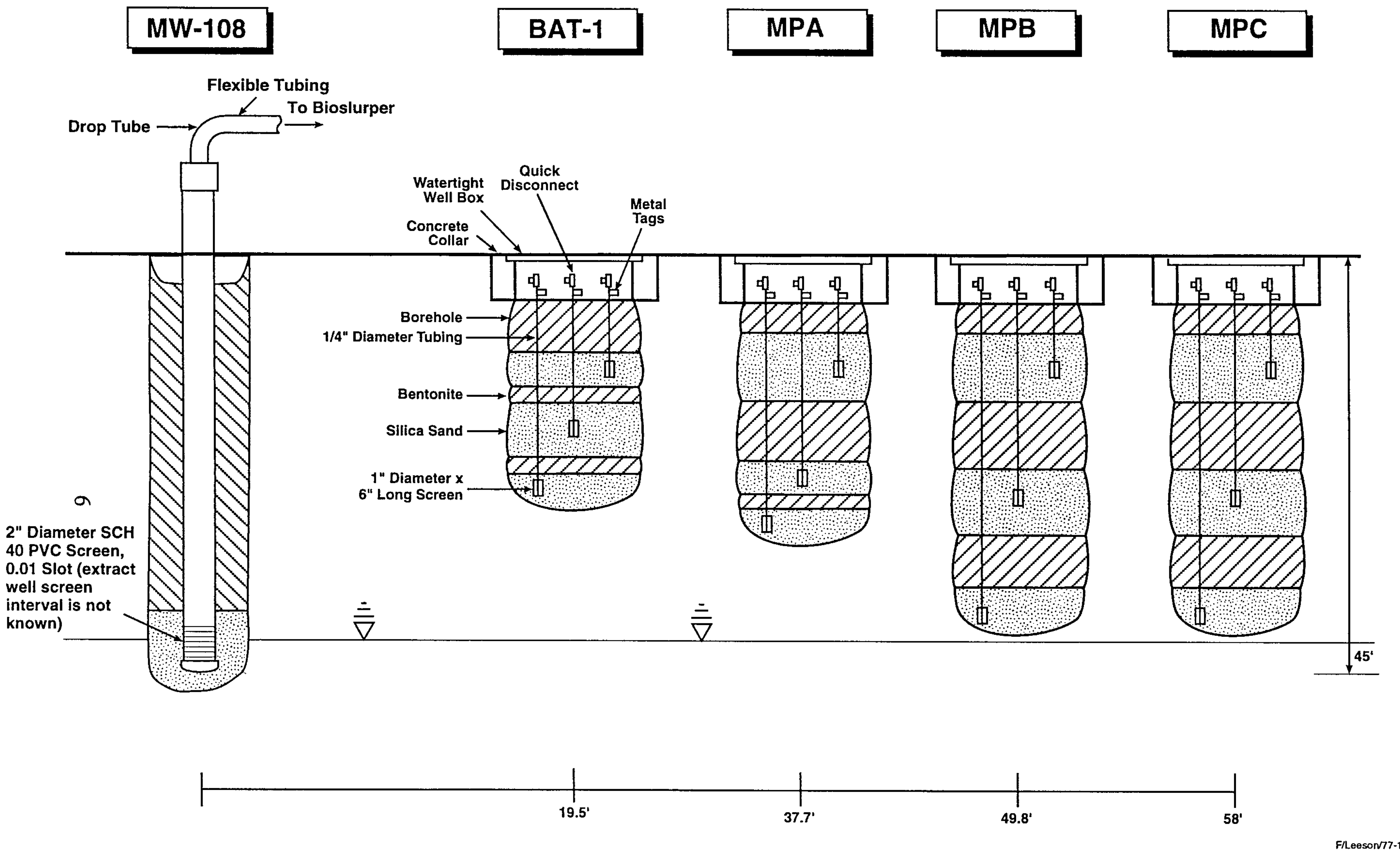


Figure 2. Schematic Diagram Showing Construction Details of Monitoring Well MW-108 and Soil Gas Monitoring Points

bentonite clay chips. After placement, the bentonite clay was hydrated with water to expand the chips and provide a seal. At the existing monitoring points, the screened intervals were at 12, 18.5, and 25.5 ft bgl at MPA, 12, 24, and 29 ft bgl at MPB, and 12, 26, and 39 ft bgl at MPC. Precise construction details for the existing monitoring points is not known.

After installation of the monitoring points, initial soil gas measurements were taken with a GasTech portable O_2/CO_2 meter and a GasTech TraceTechtor portable hydrocarbon meter. Oxygen limitation was observed at all monitoring points, with oxygen concentrations below 5% at nearly every screened interval. TPH concentrations were high, ranging from 3,600 ppmv to 11,400 ppmv (Table 1).

3.4 Soil Sampling and Analysis

Two soil samples were collected during the installation of monitoring point BAT-1 and were labeled PLT-1 and PLT-2. Sample PLT-1 was collected from 25 to 25.5 ft bgl and sample PLT-2 was collected from 25.5 to 26 ft bgl using a split spoon sampler with brass sleeves. The samples were placed in an insulated cooler, chain-of-custody records and shipping papers were completed, and the samples were sent to Alpha Analytical, Inc., in Sparks, Nevada. Samples were analyzed for BTEX, bulk density, particle size, porosity, and TPH. The laboratory analytical report is provided in Appendix B.

3.5 LNAPL Recovery Testing

3.5.1 System Setup

The bioslurping pilot test system is a trailer-mounted mobile unit. The vacuum pump (Atlantic Fluidics Model A100, 7.5-hp liquid ring pump), filter box, oil/water separator, and required support equipment were carried to the test location on a trailer. The trailer was located near the monitoring well, the well cap was removed, a well seal was placed on the top of the well, and the slurper tube was lowered into the well. The slurper tube was attached to the vacuum pump. Different configurations of the well seal and the placement depth of the slurper tube allow for simulation of skimmer pumping, operation in the bioslurping configuration, or simulation of drawdown pumping. Extracted soil gas was treated through a Thermatrix®, which was operated by

Table 1. Initial Soil-Gas Compositions

Monitoring Point	Depth (ft)	Oxygen (%)	Carbon Dioxide (%)	TPH (ppmv)
MPA	12.0	3.3	16	10,400
	24.0	3.0	17	11,400
	39.0	3.7	14	10,600
MPB	12.0	6.9	12	9,000
	26.0	4.0	15	8,600
	39.0	2.8	15	10,400
MPC	12.0	1.5	14	0
	26.0	2.0	11	3,600
	39.0	3.0	10	8,600

Parsons Engineering-Science. Extracted groundwater was treated by passing the recovered fluid through the filter box, the oil/water separator, and a settling tank. The groundwater was then discharged into the Base's treatment plant.

A brief system startup test was performed prior to LNAPL recovery testing to ensure that all system components were working properly. The system checklist is provided in Appendix C. All site data and field testing information were recorded in a field notebook and then transcribed onto pilot test data sheets provided in Appendix D.

3.5.2 Skimmer Pump Test

Prior to test initiation, depths to LNAPL and groundwater were measured. The liquid ring pump was used to conduct the skimmer pump test with the wellhead open to the atmosphere (Figure 3). The drop tube was held in position at 42.6 ft bgl. The pump was started 12:00 pm, 29 August 1996, to begin the skimmer pump test. The test was operated for a total of 44 hr, with a shutdown for approximately 5 hours after approximately 38 hr of testing when the Thermatrix® shutdown. The pump vacuum was approximately 22″Hg and the vapor flowrate was approximately 36 scfm. The

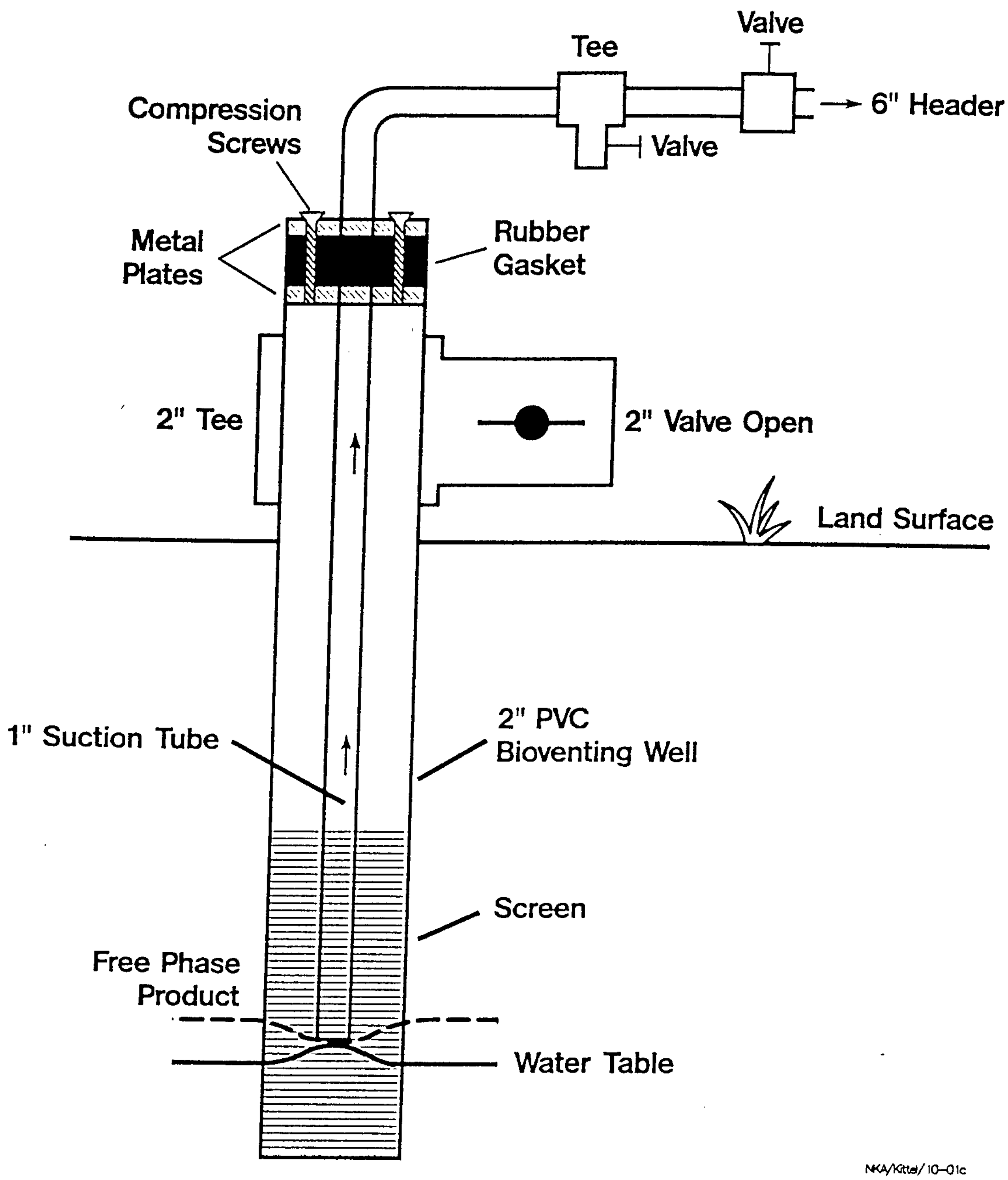


Figure 3. Drop Tube Placement and Valve Position for the Skimmer Pump Test

LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the skimmer pump test. Test data sheets are provided in Appendix D.

3.5.3 Bioslurper Pump Test

Upon completion of the skimmer pump test, preparations were made to begin the bioslurper pump test. The LNAPL and groundwater depth were measured prior to any recovery testing. The slurper tube was set at the LNAPL/groundwater interface at a depth of 41.7 ft bgl. The sanitary well seal was positioned inside the well, sealing the wellhead and allowing the pump to establish a vacuum in the well (Figure 4). A pressure gauge was installed at the wellhead to measure the vacuum inside the extraction well. The liquid ring pump was started at 2:45 pm, 31 August 1996, to begin the bioslurper pump test. The test was initiated approximately 2.2 hr after the skimmer pump test and was operated for 97 hr. The pump vacuum was approximately 24″Hg, the vapor flowrate was approximately 14 scfm, and the well vacuum ranged from 9 to 12″H_2O. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the bioslurper pump test. The data sheets are provided in Appendix D.

An LNAPL sample was collected from the oil/water separator during the bioslurper pump test and was labeled PAFB-F. The sample was sent to Alpha Analytical, Inc., in Sparks, Nevada for analysis of BTEX.

3.5.4 Second Skimmer Pump Test

Upon completion of the bioslurper pump test, preparations were made to begin the second skimmer pump test. Prior to test initiation, depths to LNAPL and groundwater were measured. The bioslurper system was used to conducted this skimmer pump test.. The slurper tube was set at a depth of 41.7 bgl. The drop tube was held in position by the well seal, and was positioned to leave the wellhead vented to the atmosphere. The liquid ring pump and oil/water separator were primed with known amounts of groundwater to ensure that any LNAPL or groundwater entering the system could be quantified. The flow totalizers for the LNAPL and aqueous effluent were zeroed, and the liquid ring pump was started at 5:10 pm, 4 September 1996, to begin the second skimmer pump test. The test was initiated approximately 2 hr after the bioslurper pump test and was operated continuously for 19 hours. The pump vacuum was approximately 22″Hg and the vapor flowrate was approximately 40

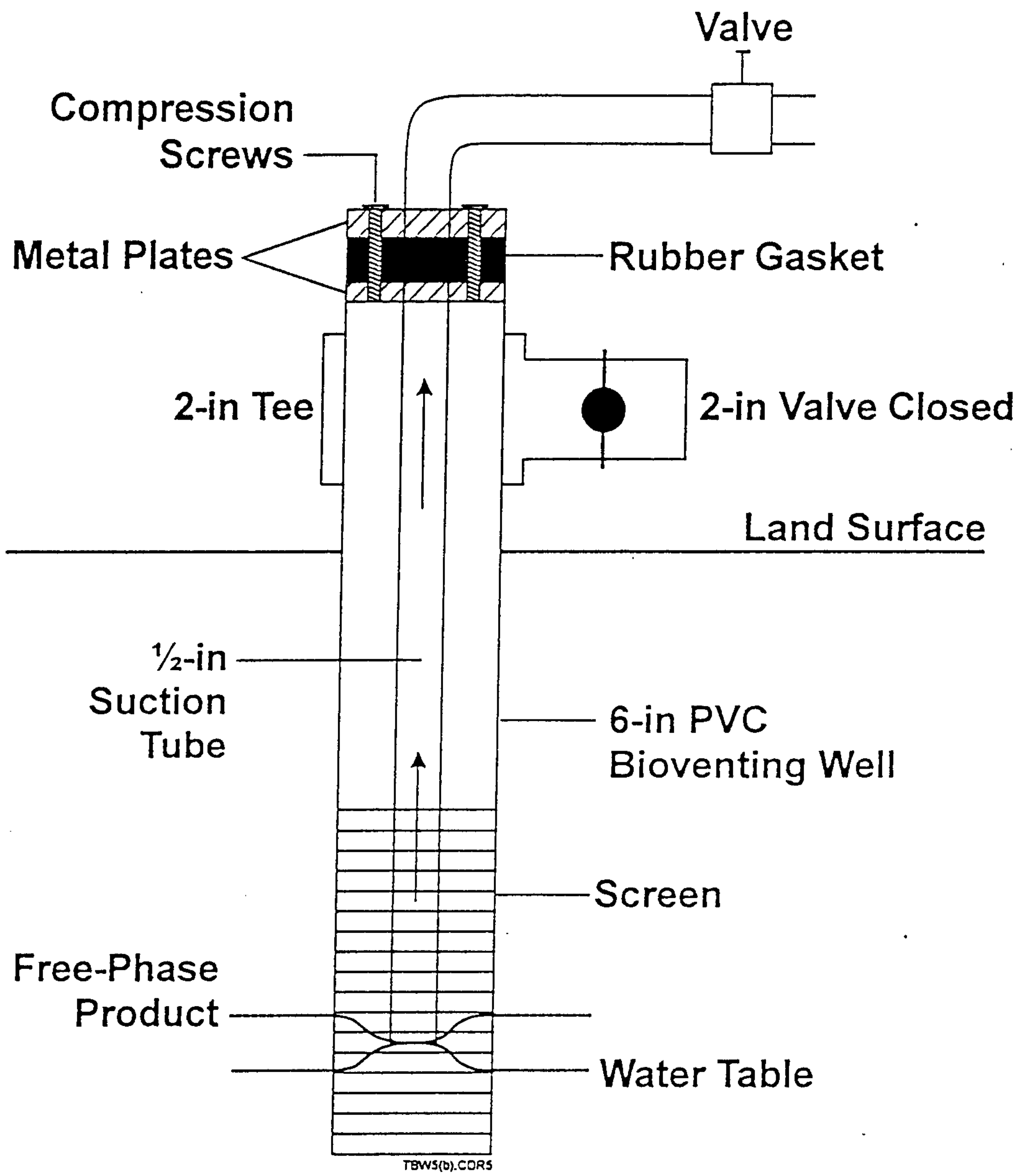


Figure 4. Drop Tube Placement and Valve Position for the Bioslurper Pump Test

to 49 scfm. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the skimmer pump test. Test data sheets are provided in Appendix D.

3.5.5 Drawdown Pump Test

Upon completion of the second skimmer pump test, preparations were made to begin the drawdown pump test. Drawdown testing was conducted to determine if a cone of groundwater depression would enhance LNAPL recovery. The slurper tube was positioned 18 inches below the LNAPL/water interface measured prior to any recovery pump testing (Figure 5). The liquid ring pump was started at 11 pm, 5 September 1996, to begin the drawdown pump test. The test was initiated approximately 1 hr after the second skimmer pump test was completed and was operated continuously for 23 hr. The pump vacuum was approximately 24″Hg and the vapor flowrate was approximately 52 to 57 scfm. The LNAPL and groundwater extraction rates were monitored throughout the test, as were all other relevant data for the drawdown pump test. Test data sheets are provided in Appendix D.

3.5.6 Off-Gas Sampling and Analysis

Two soil gas samples were collected during the bioslurper pump test at monitoring well MW-108. Samples PAFB-V-1 and PAFB-V-2 were collected after 90 and 92 hr of operation, respectively. The samples were collected in Summa® canisters and sent under chain of custody to Air Toxics, Ltd., in Folsom, California, for analyses of BTEX and TPH, using EPA Method TO-3.

3.5.7 Groundwater Sampling and Analysis

One groundwater sample was collected during the bioslurper pump test at monitoring well MW-108 and was labeled PAFB-W-1. The sample was collected from the oil/water separator outlet after approximately 95.5 hr of operation. The sample was collected in a 40-mL VOA vial containing hydrochloric acid (HCl) preservative. Samples were checked to ensure no headspace was present and were then shipped on ice and sent under chain of custody to Alpha Analytical, Inc., in Sparks, Nevada for analyses of BTEX and TPH (purgeable).

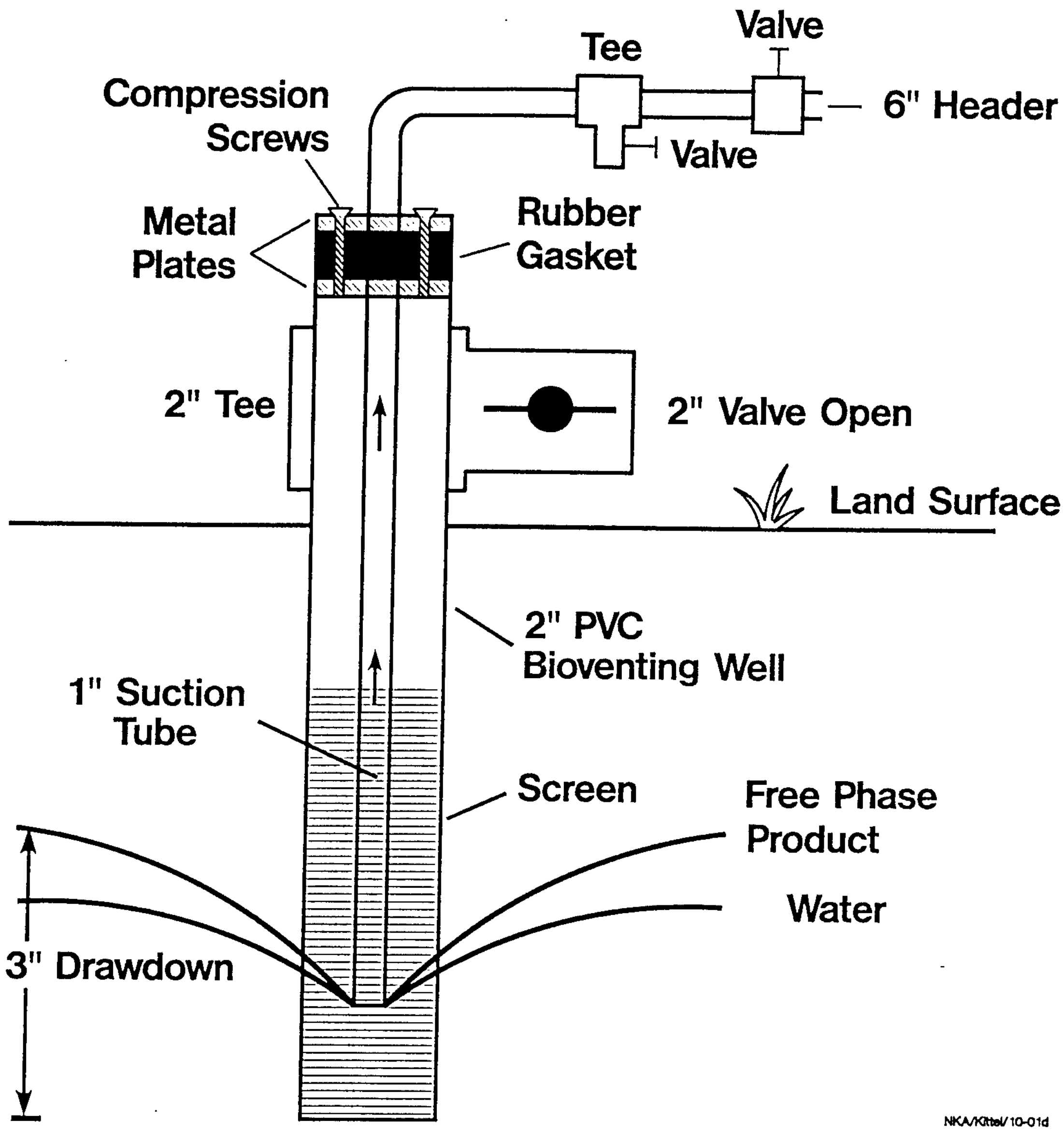


Figure 5. Drop Tube Placement and Valve Position for the Drawdown Pump Test

3.6 Bioventing Analyses

3.6.1 Soil Gas Permeability Testing

The soil gas permeability test data were collected during the bioslurper pump test at monitoring well MW-108. Before a vacuum was established in the extraction well, the initial soil gas pressures at the three installed monitoring points were recorded. The start of the bioslurper pump test created a steep pressure drop in the extraction well which was the starting point for the soil gas permeability testing. Soil gas pressures were measured at each of the three monitoring points at all depths to track the rate of outward propagation of the pressure drop in the extraction well. Soil gas pressure data were collected frequently during the first 20 minutes of the test. The soil gas pressures were recorded throughout the bioslurper pump test to determine the bioventing radius of influence. Test data are provided in Appendix E.

3.6.2 In Situ Respiration Testing

Air containing approximately 1.5% helium was injected into four monitoring points for approximately 24 hr beginning on 5 September 1996. The setup for the in situ respiration test is described in the Test Plan and Technical Protocol a Field Treatability Test for Bioventing (Hinchee et al., 1992). A ½-hp diaphragm pump was used for air and helium injection. Air and helium were injected through monitoring points Bat-1-18.5′, MPA-12.0′, MPA-39.0′, and MPB-26.0′. After the air/helium injection was terminated, soil gas concentrations of oxygen, carbon dioxide, TPH, and helium were monitored periodically. The in situ respiration test was terminated on 17 September 1996. Oxygen utilization and biodegradation rates were calculated as described in Hinchee et al. (1992). Raw data for these tests are presented in Appendix F.

Helium concentrations were measured during the in situ respiration test to quantify helium leakage to or from the surface around the monitoring points. Helium loss over time is attributable to either diffusion through the soil or leakage. A rapid drop in helium concentration usually indicates leakage. A gradual loss of helium along with a first-order curve generally indicates diffusion. As a rough estimate, the diffusion of gas molecules is inversely proportional to the square root of the molecular weight of the gas. Based on molecular weights of 4 for helium and 32 for oxygen, helium diffuses approximately 2.8 times faster than oxygen, or the diffusion of oxygen is 0.35 times the rate of helium diffusion. As a general rule, we have found that if helium concentrations at test completion are at least 50 to 60% of the initial levels, measured oxygen uptake rates are representative. Greater helium loss indicates a problem, and oxygen utilization rates are not considered representative.

4.0 RESULTS

This section documents the results of the site characterization, the comparative LNAPL recovery pump test, and other supporting tests conducted at Plattsburgh AFB.

4.1 Baildown Test Results

Results from the baildown tests are presented in Tables 2 and 3. Baildown recovery tests provide a qualitative indication of the presence of mobile, free-phase LNAPL and recovery potential. Overall, the baildown recovery tests indicated a relatively rapid rate of LNAPL recovery into the wells. At monitoring well MW-108, LNAPL recovered to initial levels by the end of the 17 hr baildown test. At the extraction well, LNAPL recovered to a level approximately 87% of the initial LNAPL thickness. Based on these results, pilot testing was initiated on monitoring well MW-108.

4.2 Soil Sample Analyses

Table 4 shows the TPH and BTEX concentrations measured in soil samples collected at Site FT-002. TPH concentrations were relatively high in both samples at 1,100 mg/kg. BTEX components were below detection limits in both samples, except for total xylene (average 1.5 mg/kg). The results of the physical characterization and inorganic analysis of the soil are presented in Table 5. Soils were very permeable, with soils consisting primarily of sand.

Table 2. Results of Baildown Testing in Monitoring Well MW-108

Sample Collection Time	Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)
Initial Reading 8/26/96-1450	41.77	41.04	0.73
8/26/96-1519	41.30	41.06	0.24
8/26/96-1519.3	41.40	41.06	0.34
8/26/96-1520	41.35	41.06	0.29
8/26/96-1520.3	41.43	41.06	0.37
8/26/96-1524	41.40	41.05	0.35
8/26/96-1525	41.40	41.04	0.36
8/26/96-1526	41.40	41.04	0.36
8/26/96-1528	41.40	41.04	0.36
8/26/96-1530	41.40	41.03	0.37
8/26/96-1532	41.41	41.04	0.37
8/26/96-1534	41.46	41.05	0.41
8/26/96-1538	41.53	41.07	0.46
8/26/96-1542	41.56	41.08	0.48
8/26/96-1551	41.59	41.08	0.51
8/26/96-1600	41.63	41.08	0.55
8/26/96-1621	41.69	41.09	0.60
8/26/96-1635	41.71	41.09	0.62
8/26/96-1722	41.77	41.09	0.68
8/26/96-1758	41.79	41.08	0.71
8/27/96-0830	41.86	41.10	0.76

Table 3. Results of Baildown Testing in the Extraction Well

Sample Collection Time	Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)
Initial Reading 8/26/96-1642	40.32	39.78	0.54
8/26/96-1650	40.30	39.96	0.34
8/26/96-1720	40.24	39.92	0.32
8/26/96-1723	40.20	39.88	0.32
8/26/96-1725	40.20	39.88	0.32
8/26/96-1734	40.20	39.84	0.36
8/26/96-1758	40.18	39.83	0.35
8/27/96-0827	40.32	39.83	0.49

Table 4. TPH and BTEX Concentrations in Soil Samples

Parameter	Concentration (mg/kg)	
	PLT-1	**PLT-2**
TPH (purgeable)	1,100	1,100
Benzene	<0.20	<0.20
Toluene	<0.20	<0.20
Ethylbenzene	<0.20	<0.20
Total Xylenes	1.1	1.8

Table 5. Physical Characterization of Soils

Parameter		Sample	
		PLT-1	PLT-2
Moisture Content (%)		NA	NA
Density (g/cm^3)		1.53	1.79
Porosity (%)		42.3	32.5
Particle Size	Sand	98.4	99.0
	Silt	1.6	1.0
	Clay	0	0

NA = Not applicable. Laboratory failed to analyze for moisture content.

4.3 LNAPL Pump Test Results

4.3.1 Initial Skimmer Pump Test Results

A small quantity of LNAPL was recovered during this test during 44 hr of extraction (Table 6). LNAPL could not be quantified until the end of the pump test due to the small quantity extracted; therefore, only the average rate over the entire test could be calculated. The average LNAPL recovery rate was 7.7 gallons/day, with a total of 14 gallons of LNAPL recovered. A total of approximately 1,905 gallons of groundwater was produced with an average production rate of 990 gallons/day. Results of LNAPL recovery versus time are shown in Figure 6.

4.3.2 Bioslurper Pump Test Results

LNAPL recovery rates increased substantially during the bioslurper pump test (Figure 6). Bioslurper testing was conducted for approximately four days, with the LNAPL recovery remaining relatively constant throughout testing, with an average LNAPL recovery rate of 41 gallons/day (Table 6). A total of 165.3 gallons of LNAPL and 8,678 gallons of groundwater was extracted, with a daily

Table 6. Pump Test Results at Monitoring Well MW-108

Time (Days)	Recovery Rate (gallons/day)							
	Skimmer Pump Test		Bioslurper Pump Test		Second Skimmer Pump Test		Drawdown Pump Test	
	LNAPL	Groundwater	LNAPL	Groundwater	LNAPL	Groundwater	LNAPL	Groundwater
1	7.7[1]	1,200	36	2,400	21	870	13	1,800
2	7.7[1]	780	46	2,100	NA	NA	NA	NA
3	NA	NA	41	1,900	NA	NA	NA	NA
4	NA	NA	41	2,300	NA	NA	NA	NA
Average	7.7	990	41	2,200	21	870	13	1,800
Total Recovery (gal)	14	1,905	165.3	8,678	16.3	680	12.7	1,741

1 Fuel could not be quantified until the end of the skimmer pump test. The value shown here represents the average based on total recovery at end of test.

NA = Not applicable.

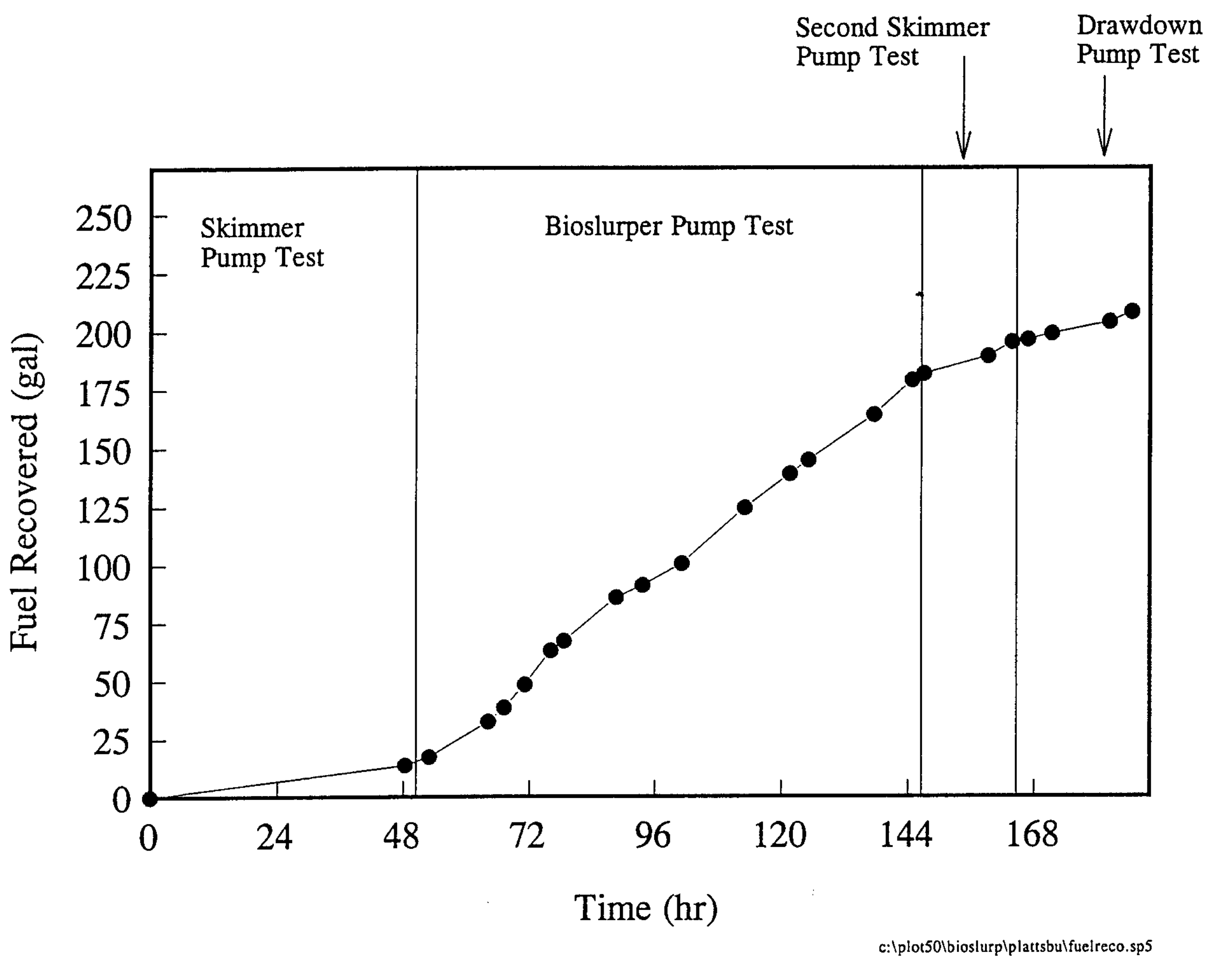


Figure 6. Fuel Recovery Versus Time During Each Pump Test in Monitoring Well MW-108

average groundwater production rate of 2,200 gallons/day (Table 6). The LNAPL recovery rate versus time is shown in Figure 7.

Soil gas concentrations were measured during the bioslurper test at monitoring points adjacent to monitoring well MW-108 to determine if the vadose zone was being oxygenated via the bioslurper action. Oxygen concentrations varied at all monitoring points; however, oxygen levels fluctuated, generally increasing and decreasing with time (Table 7). This could be the result of pockets of oxygenated and oxygen-limited soil gas passing by the monitoring points. Also, there were trenches in the area which may have influenced soil gas results. Pressure changes were observed up to 50 ft from the bioslurper well and, it is our experience that wherever pressure changes are detected, aeration will occur. Therefore, it is likely that these areas will become aerated over time.

4.3.3 Second Skimmer Pump Test

The LNAPL recovery rate was higher during the second skimmer pump test than that observed during the initial skimmer pump test, perhaps due to increased LNAPL mobility due to the bioslurper pump test. Approximately 16.3 gallons of LNAPL and 680 gallons of groundwater were recovered during the second skimmer pump test, with daily average recovery rates of 21 and 870 gallons/day, respectively (Table 6). These results demonstrate that operation of the bioslurper system in the skimmer mode was an effective means of free-product recovery, although recovery is less than that observed during bioslurping.

4.3.4 Drawdown Pump Test

Drawdown pump testing was conducted to determine if a cone of groundwater depression would enhance LNAPL recovery. The water table was depressed 18 inches below the static water table in monitoring well MW-108. Less LNAPL but more groundwater was recovered during this test than during the skimmer pump tests (Table 6). LNAPL and groundwater recovery rates were on the order of 13 and 1,800 gallons/day, respectively. These results demonstrate that the vacuum gradient maintained during the bioslurper test resulted in higher fluid recovery rates than the 18 inch-groundwater drawdown test.

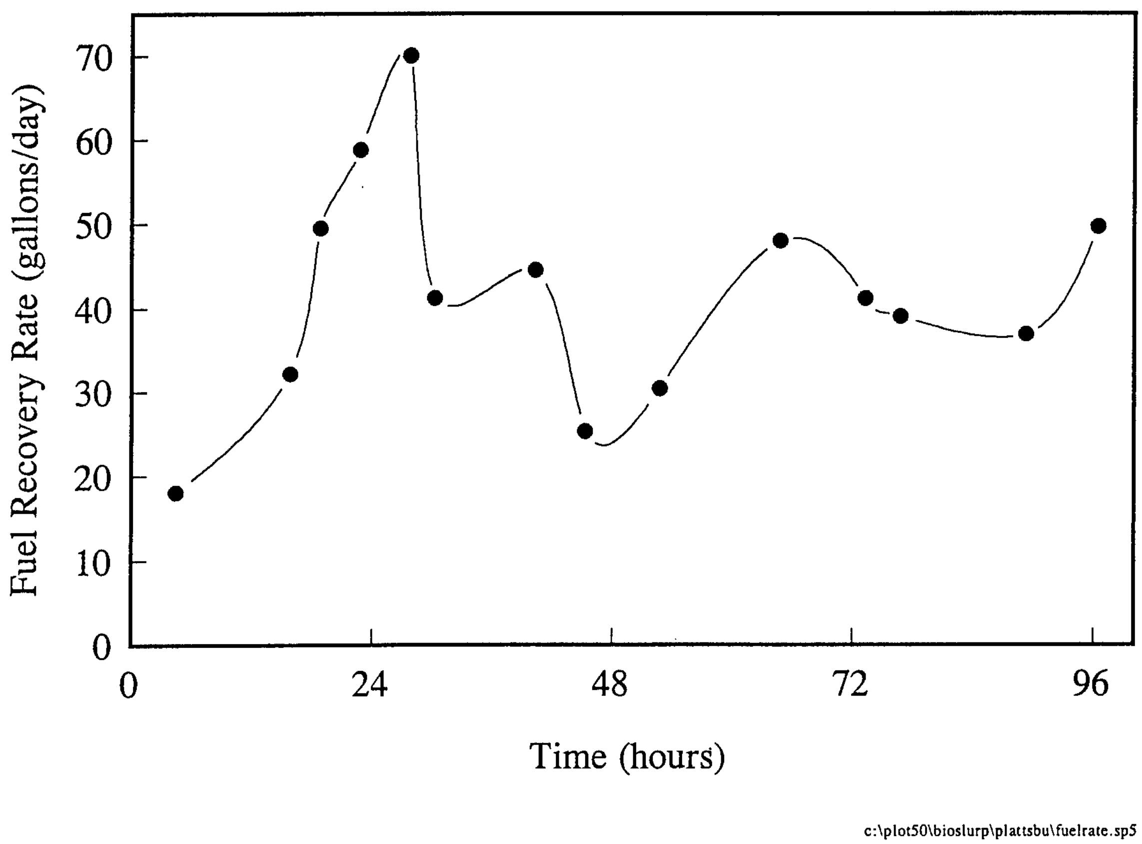


Figure 7. **Fuel Recovery Rate Versus Time During the Bioslurper Pump Test in Monitoring Well MW-108**

Table 7. **In Situ Soil Gas Oxygen Concentrations During the Bioslurper Pump Test**

Monitoring Point	Oxygen Concentrations (%) Versus Time (hours)		
	0	77.25	96
MPA-12.0	1.0	7.0	7.0
MPA-24.0	0	2.5	0
MPA-39.0	0	9.0	4.0
MPA-12.0	0.5	1.0	1.0
MPB-26.0	0	1.0	0
MPB-39.0	0	3.5	1.0
BAT-1-12.0	17	16	16
BAT-1-18.5	4.5	2.0	1.0
BAT-1-25.5	2.0	1.0	0

4.3.5 Extracted Groundwater, LNAPL, and Off-Gas Analyses

Results of groundwater analyses are shown in Table 8. Contaminant concentrations were relatively high, with TPH and BTEX concentrations of 44 mg/L and 10.5 mg/L, respectively. The on-site water treatment equipment, consisting of a filter tank, oil/water separator, and clarification tanks, resulted in water effluent that is considered compatible with typical sanitary sewer discharge limits.

The results from the off-gas analyses are presented in Table 9. All extracted soil gas was treated with the Thermatrix®. Given a vapor flowrate of 14 scfm and using an average concentration of 47,000 ppmv TPH and 66 ppmv benzene, approximately 190 lb/day of TPH and 0.26 lb/day of benzene were removed in the vapor phase. Thus, mass removal in the vapor phase is significant. Higher vapor mass removal rates are more often sustained at those sites where liquid product recovery is sustained.

The composition of LNAPL is shown in Table 10 in terms of BTEX concentrations. Benzene was below detection limits in the LNAPL sample.

Table 8. BTEX and TPH Concentrations in Extraction Groundwater During the Bioslurper Pump Test

Parameter	PAFB-W-1
TPH (purgeable)	44
Benzene	0.68
Toluene	3.5
Ethylbenzene	0.81
Total Xylenes	5.5

Table 9. BTEX and TPH Concentrations in Extracted Soil Gas During the Bioslurper Pump Test

Parameter	Concentration (ppmv)	
	PAFB-V-1	PAFB-V-2
TPH as jet fuel	34,000	13,000
Benzene	110	22
Toluene	530	200
Ethylbenzene	120	58
Total Xylenes	420	220

Table 10. BTEX Concentrations in LNAPL

Compound	Concentration (mg/kg)
Benzene	<950
Toluene	1,700
Ethylbenzene	1,500
Total Xylenes	11,000

4.4 Bioventing Analyses

4.4.1 Soil Gas Permeability and Radius of Influence

The radius of influence is calculated by plotting the log of the pressure change at a specific monitoring point versus the distance from the extraction well. The radius of influence is then defined as the distance from the extraction well where 0.10 inch of H_2O can be measured. During the soil gas permeability test, although pressure changes were observed at every monitoring point up to 50 ft from the bioslurper well, pressure changes were similar at each monitoring point, making it impossible to determine the radius of influence (Figure 8). It is apparent that there was a radius of influence of at least 50 ft, but it is not possible to predict how much large the radius of influence may be. Monitoring points installed further away from the bioslurper well may be necessary to more accurately determine the radius of influence.

4.4.2 In Situ Respiration Test Results

Results from the in situ respiration test are presented in Table 11. Oxygen utilization rates were relatively high, ranging from 0.17 to 0.65 $\%O_2$/hr. Biodegradation rates ranged from 2.8 to 11 mg/kg-day. These results indicate that biodegradation in these locations is significant and that bioventing is feasible at this site.

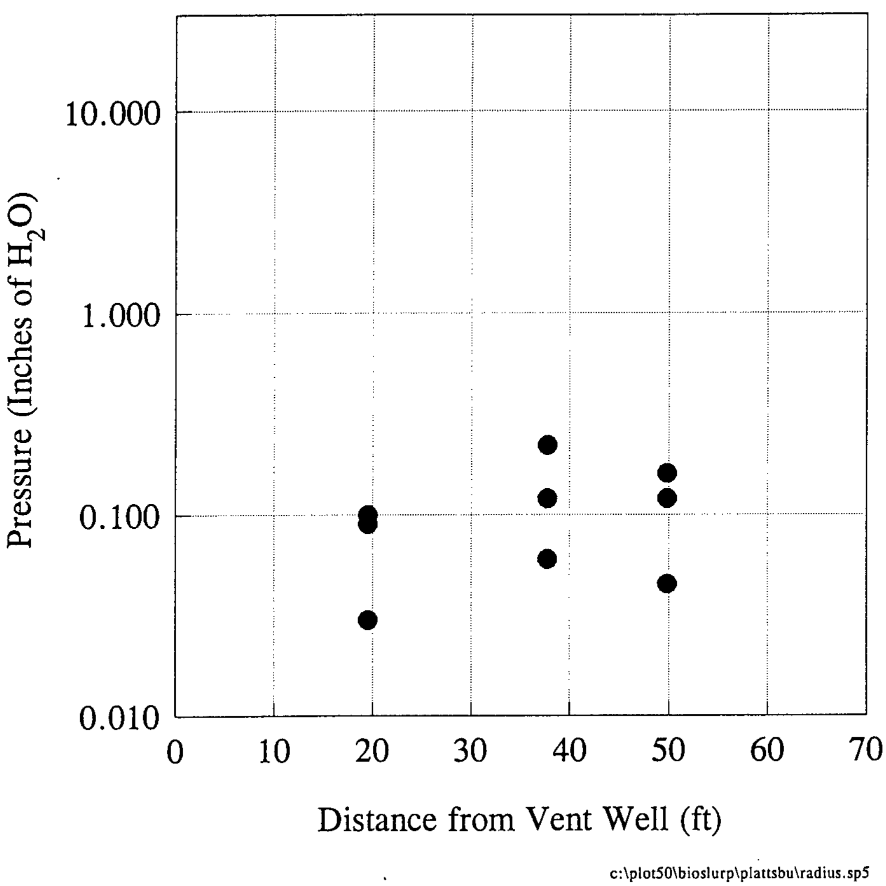


Figure 8. **Radius of Influence Determination Using Soil Gas Pressure Change Versus Distance From Extraction Well**

Table 11. In Situ Respiration Test Results

Monitoring Point	Oxygen Utilization Rate (%.day)	Biodegradation Rate (mg/kg-day)
BAT-1	0.65	11
MPA-12.0	0.62	10
MPA-39.0	0.53	8.7
MPB-26.0	0.17	2.8

5.0 DISCUSSION AND CONCLUSIONS

The main objective of the field pilot test at Site FT-002, Plattsburgh AFB was to determine if LNAPL recovery is feasible and to select the most effective method of LNAPL recovery.

Baildown recovery tests were conducted at monitoring wells MW-108 and an extraction well. Baildown recovery tests provide a qualitative indication of the presence of mobile, free-phase LNAPL and recovery potential. Overall, the baildown recovery tests indicated a relatively rapid rate of LNAPL recovery into the wells. At monitoring well MW-108, LNAPL recovered to initial levels by the end of the 17 hr baildown test. At the extraction well, LNAPL recovered to a level approximately 87% of the initial LNAPL thickness. Based on these results, pilot testing was initiated on monitoring well MW-108.

Direct pumping tests were conducted at monitoring well MW-108. Skimmer pump testing was conducted at monitoring well MW-108 mode for approximately two days. A small quantity of LNAPL was recovered during this test during 44 hr of extraction. LNAPL could not be quantified until the end of the pump test due to the small quantity extracted; therefore, only the average rate over the entire test could be calculated. The average LNAPL recovery rate was 7.7 gallons/day, with a total of 14 gallons of LNAPL recovered. A total of approximately 1,905 gallons of groundwater was produced with an average production rate of 990 gallons/day. LNAPL recovery rates increased substantially during the bioslurper pump test. Bioslurper testing was conducted for approximately four days, with the LNAPL recovery remaining relatively constant throughout testing, with an average LNAPL recovery rate of 41 gallons/day. A total of 165.3 gallons of LNAPL and 8,678 gallons of groundwater was extracted, with a daily average groundwater production rate of 2,200 gallons/day. The LNAPL recovery rate was higher during the second skimmer pump test than that observed during the initial skimmer pump test, perhaps due to increased LNAPL mobility due to the bioslurper pump test. Approximately 16.3 gallons of LNAPL and 680 gallons of groundwater were recovered during the second skimmer pump test, with daily average recovery rates of 21 and 870 gallons/day, respectively. These results demonstrate that operation of the bioslurper system in the skimmer mode was an effective means of free-product recovery, although recovery is less than that observed during bioslurping.

Drawdown pump testing was conducted to determine if a cone of groundwater depression would enhance LNAPL recovery. The water table was depressed 18 inches below the static water table in monitoring well MW-108. Less LNAPL but more groundwater was recovered during this test than during the skimmer pump tests. LNAPL and groundwater recovery rates were on the order of 13 and 1,800 gallons/day, respectively. These results demonstrate that the vacuum gradient maintained during the bioslurper test resulted in higher fluid recovery rates than the 18 inch-groundwater drawdown test.

Bioslurping also promotes mass removal in the form of in situ biodegradation via bioventing and soil gas extraction. Vapor phase mass removal is the result of soil gas extraction as well as volatilization that occurs during the movement of LNAPL free product through the extraction network. All extracted soil gas was treated with the Thermatrix®. Given a vapor flowrate of 14 scfm and using an average concentration of 47,000 ppmv TPH and 66 ppmv benzene, approximately 190 lb/day of TPH and 0.26 lb/day of benzene were removed in the vapor phase. Thus, mass removal in the vapor phase is significant. Higher vapor mass removal rates are more often sustained at those sites where liquid product recovery is sustained.

The initial soil gas profiles at the site displayed oxygen-deficient, carbon dioxide-rich, high total volatile hydrocarbon vapor conditions. These conditions indicate that natural biodegradation of residual petroleum hydrocarbons has occurred, but is limited by oxygen availability. Soil gas concentrations were measured during the bioslurper test at monitoring points adjacent to monitoring well MW-108 to determine if the vadose zone was being oxygenated via the bioslurper action. Soil gas concentrations were measured during the bioslurper test at monitoring points adjacent to monitoring well MW-108 to determine if the vadose zone was being oxygenated via the bioslurper action. Oxygen concentrations varied at all monitoring points; however, oxygen levels fluctuated, generally increasing and decreasing with time. This could be the result of pockets of oxygenated and oxygen-limited soil gas passing by the monitoring points. Also, there were trenches in the area which may have influenced soil gas results. Pressure changes were observed up to 50 ft from the bioslurper well and, it is our experience that wherever pressure changes are detected, aeration will occur. Therefore, it is likely that these areas will become aerated over time.

In situ biodegradation rates of 2.8 to 11 mg/kg-day were measured at four different locations. Based on a radius of influence of at least 50 ft and a hydrocarbon-impacted soil thickness of 41 ft, mass removal rates via biodegradation are on the order of 79 to 310 lbs of hydrocarbon per day. Thus, mass removal rates via biodegradation are as significant as the vapor phase removal rates measured during the bioslurper test. These results indicate that bioventing is feasible at this site. Air injection bioventing is preferable over bioslurping and soil vapor extraction with respect to the elimination of hydrocarbon vapor emissions.

In summary, the on-site testing at Site FT-002, Plattsburgh AFB, included the direct testing of gravity-driven and vacuum-driven LNAPL free product recovery techniques, bioventing, physical sampling, and tests relevant to soil vapor extraction. Liquid phase recovery was sustainable under all conditions, but was highest during bioslurping. In addition, bioslurping appeared to increase the flow of LNAPL to the well, as evidenced by increased LNAPL recovery rates during the second skimmer pump test in comparison to the initial skimmer pump test. The in situ respiration test and vadose zone radius of influence testing demonstrate that bioventing may be feasible at this site. Bioslurping appears to be the most suitable recovery technique for this site, providing long-term disposal of extracted water is possible.

6.0 REFERENCES

Battelle, 1995. Test Plan and Technical Protocol for Bioslurping. Report prepared by Battelle Columbus Operations for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. Test Plan and Technical Protocol for a Field Treatability Test for Bioventing (Rev. 2). Report prepared by Battelle Columbus Operations, U.S. Air Force Center for Environmental Excellence, and Engineering Sciences, Inc., for the U.S. Air Force Center for Environmental Excellence, Brooks Air Force Base, Texas.

APPENDIX A

SITE-SPECIFIC TEST PLAN FOR BIOSLURPER FIELD ACTIVITIES AT PLATTSBURGH AFB, NEW YORK

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August 14, 1996

Headquarters, Air Force Center
for Environmental Excellence
8001 Arnold Drive (Bldg. 642)
Brooks AFB, TX 78235-5357

Attention: Mr. Patrick Haas

Dear Patrick:

WORK PLAN ADDENDUM FOR FREE PRODUCT RECOVERY TESTING AT PLATTSBURG AFB, NEW YORK (A002), CONTRACT NO. F41624-94-C-8012

The purpose of this letter report is to summarize the project activities to be conducted as part of the pilot-scale demonstration of free product recovery field testing at Plattsburg AFB, New York. This work is being conducted under the US Air Force umbrella work plan titled "Installation Restoration Program Action Memorandum, Fire Training Area 2 (FT-002), Plattsburg AFB, Plattsburg, New York."

1.0 INTRODUCTION

The Air Force Center for Environmental Excellence is conducting a multi-site initiative to develop more effective methods of determining the feasibility of free product recovery as well as the best method of recovery. The technologies tested in the Bioslurper Initiative are skimming, vacuum-enhanced free-product recovery/bioremediation (bioslurping), and drawdown pumping. The field test and evaluation are intended to demonstrate the initial feasibility of each technology by measuring system performance in the field. System performance parameters, mainly free-product recovery, will be determined at numerous sites. Field testing will be performed at many sites to determine the effects of different organic contaminant types and concentrations and different geological conditions on free product recovery effectiveness.

Plans for the field test activities are presented in two documents. The first is the overall test plan and technical protocol for the entire program, titled *Test Plan and Technical Protocol for Bioslurping* (AFCEE/Battelle, 1995). The overall plan is supplemented by plans specific to each test site. The concise site-specific plans effectively communicate regulatory background to Base personnel.

The overall test plan and protocol was developed as a generic plan for the Bioslurper Initiative to improve the accuracy and efficiency of test plan preparation. The field program requires installation and operation of the bioslurping system supported by a wide variety of site characterization, performance monitoring, and chemical analysis activities. The basic methods to be applied from site to site do not change. Preparation and review of the overall plan allows efficient documentation and review of the basic approach to the test program.

The pilot test site is Fire Training Area 2 (FT-002). Site specific data for site FT-002 is summarized in the Air Force umbrella work plan. The extraction well and soil gas monitoring points for the bioslurper field test will be installed by the Air Force prior to Battelle's mobilization to the field site. Details on well and monitoring point design are presented in the umbrella work plan.

2.0 PROJECT ACTIVITIES

The following field activities are planned for the bioslurper pilot test at Plattsburg AFB. Additional details about field testing activities are presented in the generic document *Test Plan and Technical Protocol for Bioslurping* (AFCEE/Battelle, 1995). As appropriate, specific sections in the generic Bioslurping Protocol are referenced. Table 1 shows the schedule of activities for the Bioslurper Initiative at Plattsburg AFB.

Table 1. Schedule of Bioslurper Test Activities

Pilot Test Activity	Schedule
Mobilization	August
Site Characterization Activities	day 1-2
Baildown Tests and Product/Groundwater Interface Monitoring	
Soil-Gas Survey (limited)	
System Installation	day 2-3
Test Startup	day 3
Skimmer Test (2 days)	day 3-4
Bioslurper Vacuum Extraction (4 days)	day 5-9
Soil-Gas Permeability Testing	day 5
Skimmer Test (continued)	day 10
In Situ Respiration Test — air/helium injection	day 10
In Situ Respiration Test — monitoring	day 11-12
Drawdown Pump Test (2 days)	day 11-12
Demobilization	day 12-13

3.1 Mobilization to the Site

After the site-specific test plan is approved, Battelle staff will mobilize equipment. The Base Point of Contact (POC) will have been asked in advance to find a suitable holding facility to receive any bioslurper pilot test equipment that could be sent in advance of Battelle staff. The storage facility should allow Battelle staff to easily set up the bioslurper pilot demonstration when they arrive on site. The exact mobilization date will be confirmed with the Base POC as far in advance of fieldwork as is possible. The Battelle POC will provide the Air Force POC with information on each Battelle employee who will be on site.

3.2 Site Characterization Tests

3.2.1 Baildown Tests

The baildown test is the primary test for selection of the bioslurper test well. Baildown tests will be performed at all wells on the FT-002 site that contain significant thicknesses of light, nonaqueous-phase liquid (LNAPL) to estimate the LNAPL recovery potential at those particular wells. Figure 1 displays the aerial extent of the LNAPL plume at FT-002. Well's MW-02-11, MW-02-14, MW-02-15, MW-02-06, and Recovery Wells 1 and 2 (not shown on figure 1) are all potential candidates for the pilot test extraction well.

In most cases, the well exhibiting the highest rate of LNAPL recovery will be selected for the bioslurper extraction well. Table 4 presents the volume of fuel that would be present in a 1-foot measured thickness for various size wells. Detailed procedures for the baildown tests are provided in Section 5.6 of the generic Bioslurping Protocol.

Table 4. Volumes per Unit Length for Common Well Casing Diameters

Nominal Pipe Size	Gal/ft (Schedule 40 Pipe)	Gal/ft (Schedule 80 Pipe)
2.0	0.174	0.153
3.0	0.384	0.343
4.0	0.661	0.597
6.0	1.50	1.35

3.2.2 Soil-Gas Survey (Limited)

Soil-gas survey activities will consist of monitoring previously installed soil gas monitoring points. Expected soil gas concentrations at fuel contaminated sites are as follows:

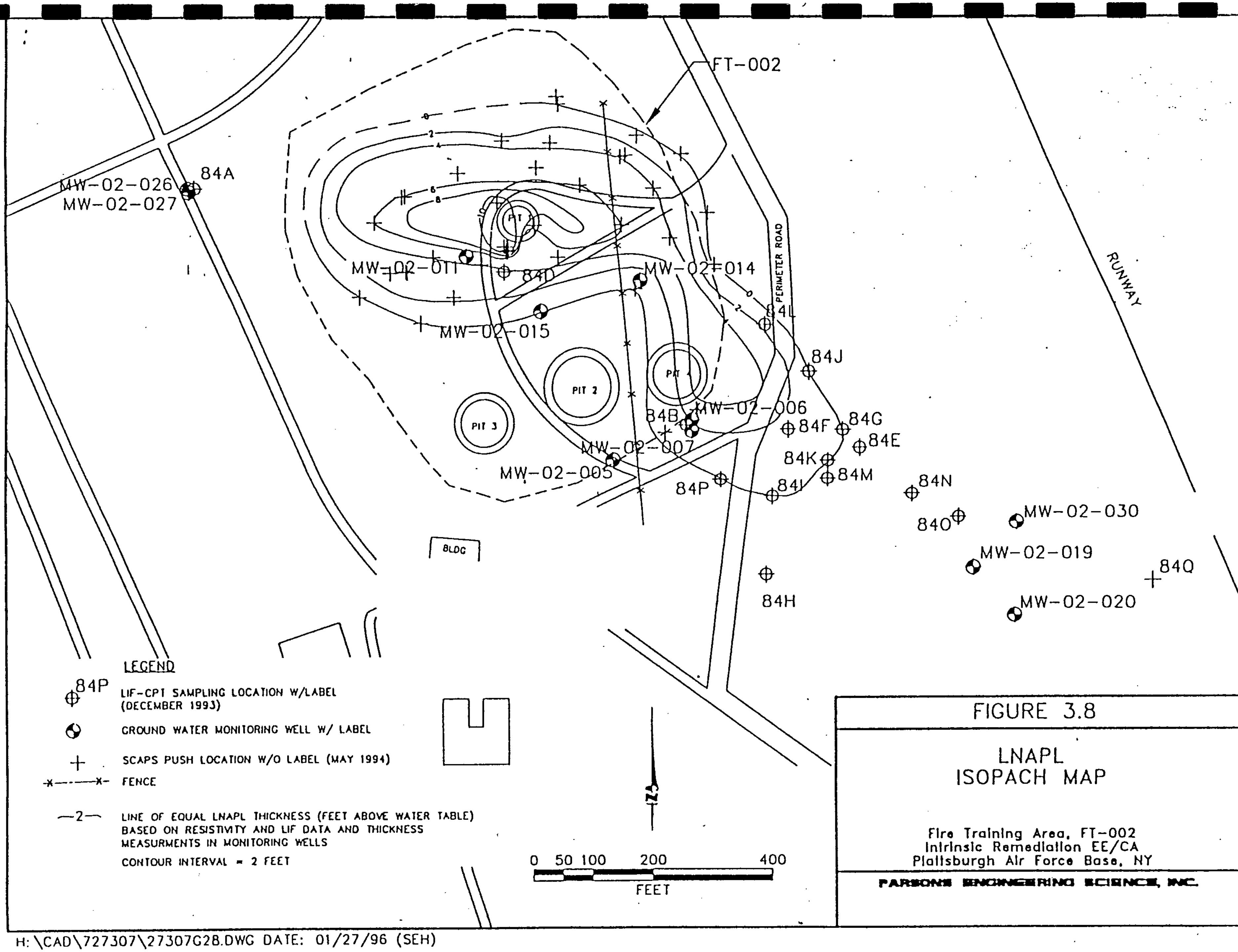

Figure 1. Areal Extent of LNAPL Plume at FT-002

1. Soil vapor from the site will exhibit high total petroleum hydrocarbon (TPH) concentrations (10,000 ppm or greater).

2. Soil vapor will contain relatively low oxygen concentrations (between 0% and 2%).

3. Soil vapor will have relatively high carbon dioxide concentrations (depending on soil type, between 2% and 10% or greater).

To obtain further information about the soil-gas survey, consult Section 5.2 of the generic Bioslurping Protocol.

3.2.3 Monitoring Point Installation

Monitoring points must be installed to determine the radius of influence that the free-product recovery system has on vadose zone contaminated soils. There are existing soil gas monitoring points at the FT-002 site. An effort will be made to utilize existing monitoring points to avoid the generation of contaminated soil cuttings. If the existing monitoring points cannot be used, new monitoring points will be installed.

After the extraction well is selected, and if existing monitoring points are unsuitable, at least three soil-gas monitoring points will be installed to measure soil-gas changes that occur during the operation of the bioslurper. These monitoring points should be located in highly contaminated soils within the free-phase plume and should be positioned to allow detailed monitoring of the in situ changes in soil-gas composition caused by the bioslurper system.

3.2.4 Soil Sampling

Soil samples will be collected to determine the physical and chemical composition of the soil near the bioslurper test site. Soil samples will be collected from the boreholes advanced for monitoring point installation. If monitoring points are not installed, a single soil boring will be hand augered at the site for sample collection. Generally, samples will be collected from the capillary fringe over the free product.

Soil samples will be analyzed for particle-size distribution, bulk density, porosity, moisture content, BTEX, and TPH. Section 5.5.1 of the generic Bioslurping Protocol will be consulted for information on the field measurements and sample collection procedures for soil sampling.

3.3 Bioslurper System Installation and Operation

Once the well to be used for the bioslurper test installation at Plattsburg AFB has been identified, the bioslurper pump and support equipment will be installed and the pilot test will be initiated.

3.3.1 System Setup

After the preliminary site characterization has been completed and the bioslurper candidate well has been selected, the equipment will be mobilized from the holding facility to the test site, and the bioslurper system will be assembled.

Before the LNAPL recovery tests are initiated, all relevant baseline field data will be collected and recorded. These data will include soil-gas concentrations, initial soil-gas pressures, the depth to groundwater, and the LNAPL thickness. Ambient soil and all atmospheric conditions (e.g., temperature, humidity, barometric pressure) also will be recorded. All emergency equipment (i.e., emergency shutoff switches and fire extinguishers) will be installed and checked for proper operation at this time.

A clear, level area near the well selected for the bioslurper test installation will be identified for two flatbed trailers that hold the equipment required for bioslurper system operation. For more information on bioslurper system installation, consult Section 6.0 of the generic Bioslurping Protocol.

3.3.2 System Shakedown

A brief startup test will be conducted to ensure that the system is constructed properly and operates safely. All system components will be checked for problems and/or malfunctions. A checklist will be provided to document the system shakedown.

3.3.3 System Startup and Test Operations

After installation is complete and the bioslurper system is confirmed to be operating properly, the LNAPL recovery tests will be started. The Bioslurper Initiative has been designed to evaluate the effectiveness of bioslurping as an LNAPL recovery technology relative to conventional gravity-driven LNAPL recovery technologies. The Bioslurper Initiative includes three separate LNAPL recovery tests: (1) a skimmer simulation test, (2) a vacuum-assisted bioslurper test, and (3) a groundwater drawdown LNAPL recovery test. The three recovery tests are described in detail in Section 7.3 of the generic Bioslurping Protocol.

The bioslurper system operating parameters that will be measured during operation are vapor discharge, aqueous effluent, LNAPL recovery volume rates, vapor discharge volume rates, and groundwater discharge volume rates. Vapor monitoring will consist of periodic monitoring of TPH using field equipment, supplemented by a minimum of two samples collected for detailed laboratory analysis. A minimum of two samples of aqueous effluent will be collected for analysis of BTEX and TPH content. Recovered LNAPL volume will recorded using an in-line flow-totalizing meter. The off-gas discharge volume will be measured using a calibrated pilot tube, and groundwater discharge volume will recorded using an in-line flow-totalizing meter. Section 8.0 of the generic Bioslurping Protocol describes process monitoring of the bioslurper system.

3.3.4 Soil-Gas Permeability Test

A soil-gas permeability test will be conducted concurrently with startup of the vacuum-assisted bioslurper operation. Soil-gas permeability data will support the process of estimating the vadose zone radius of influence of the bioslurper system. Soil-gas permeability results also will aid in determining the number of wells required if it is decided to treat the site with a large-scale bioslurper system. The soil-gas permeability test method is described in Section 5.7 of the generic Bioslurping Protocol.

3.3.5 In Situ Respiration Test

The oxygen utilization rate will be used to estimate the biodegradation rate at the site. An in situ respiration test will be conducted after completion of the bioslurper operating tests. The in situ respiration testing will involve injection of air/helium injection into selected soil-gas monitoring points followed by monitoring changes in concentration of oxygen, carbon dioxide, petroleum hydrocarbons, and helium in soil-gas near the injection point. Measurement of the soil-gas composition typically will be conducted at 2, 4, 6, and 8 hours and then every 4 to 12 hours for about 2 days. Timing of the tests will be adjusted based on oxygen-use rate. If oxygen depletion occurs rapidly, more frequent monitoring will be required. If oxygen depletion is slow, less frequent readings will be acceptable. Further information on the procedures and data collection for in situ respiration testing is given in Section 5.8 of the generic Bioslurping Protocol.

3.4 Demobilization

Once all necessary tests have been completed at the Plattsburg AFB site, the equipment will be disassembled by Battelle staff. The equipment will be returned to Battelle's corporate headquarters in Columbus, OH.

4.0 BIOSLURPER SYSTEM DISCHARGE

4.1 Vapor Discharge Disposition

A thermal oxidation vapor treatment system will be provided by the Air Force for treatment of bioslurper vapor prior to discharge, as specified in the Air Force umbrella work plan.

To ensure the safety and regulatory compliance of the bioslurper system, vapor discharge samples (TPH, O_2, and CO_2) will be collected periodically throughout the bioslurper pilot test, and field soil-gas screening instruments will be used to monitor vapor discharge concentration variability. The volume of vapor discharge will be monitored daily using air flow instruments. Laboratory analysis will be performed on a minimum of two samples from the thermal oxidation unit discharge to determine destruction efficiency.

4.2 Aqueous Influent/Effluent Disposition

The flowrate of groundwater pumped by the bioslurper will be less than 5 gpm. However, it may be necessary in New York to obtain a groundwater pumping waiver or registration permit. If one is required, the base POC will inform Battelle of the necessary steps in obtaining the waiver or permit.

Operation of the bioslurper system will generate an aqueous waste discharge that will be passed through an oil/water separator. The intention of Battelle staff will be to dispose of the wastewater by direct discharge the base industrial waste water treatment plant.

4.3 Free-Product Recovery Disposition

The bioslurper system will recover free-phase product from the pilot tests performed at Plattsburg AFB. Free product recovered by the bioslurping tests will be turned over to the Base for disposal and/or recycling. The volume of free product recovered from the Base will not be known until the tests have been performed. The maximum recovery rate for this system is 5 gpm, but the actual rate of LNAPL recovery will be much lower.

5.0 SCHEDULE

The bioslurper fieldwork at Plattsburg AFB is scheduled to begin on August 26, 1996. Field testing is expected to take approximately 2 weeks.

6.0 PROJECT SUPPORT ROLES

This section outlines some of the major functions of personnel from Battelle, Plattsburg AFB, and AFCEE during the bioslurper field test.

6.1 Battelle Activities

Battelle's responsibility in the Bioslurper Initiative at Plattsburg AFB will be to supply all necessary staff and equipment to perform all the tests on the bioslurper system. Battelle also will provide technical support in the areas of water and vapor discharge permitting, digging permits, staff support during the extended testing period, and any other technical areas that need to be addressed.

6.2 Plattsburg AFB Support Activities

To support the necessary field tests at Plattsburg AFB, the Base must be able to provide the following:

1. Any digging permits and utility clearances that need to be obtained prior to the initiation of the fieldwork. Typically, clearing a 50 ft radius from the potential extraction wells will be sufficient.

2. The Air Force will be responsible for obtaining Base and site clearance for the Battelle staff that will be working at the Base. The Base POC will be furnished with all necessary information on each staff member prior to field startup.

3. Access to the waste treatment plant must be furnished so that Battelle staff can discharge the bioslurper aqueous effluent directly to the Base treatment facility. If discharge water is stored on site, the base will be responsible for final disposition.

4. Regulatory approval, if required, must be obtained by the Base POC prior to startup of the bioslurper pilot test. The Base POC will obtain all necessary Base permits prior to mobilization to the site. Battelle will provide technical assistance in preparing regulatory approval documents.

5. The Base also will be responsible for the disposition of all waste generated from the pilot testing. Such waste includes any soil cuttings generated from drilling, and all aqueous waste streams produced from the bioslurper tests. All free product recovered from the bioslurper operation will be disposed of or recycled by the Base. Battelle will provide technical assistance in disposing of the waste generated from the bioslurper pilot test.

6. Before field activities begin, the Health and Safety Plan will be finalized with information provided by the Base POC. Table 6 is a checklist for the information required to complete the Health and Safety Plan. All emergency information will be obtained by the Site Health and Safety Office before operations begin.

Table 7. Health and Safety Information Checklist

Emergency Contacts	**Name**	**Telephone Number**
Hospital Emergency Room:	Medical Officer	
Point of Contact:	Brady Baker	518-563-2871
Fire Department:	Fire/Spill Officer	
Emergency Unit (Ambulance):		911
Security:		
Explosives Unit:		
Community Emergency Response Coordinator:		
Other:		
Program Contacts		
Air Force:	Patrick Haas	210-536-4314
Battelle:	Jeff Kittel	614-424-6122
Other:		
Emergency Routes		
Hospital (Figure maps attached)		
Other:		

6.3 AFCEE Activities

The Air Force Center for Environmental Excellence (AFCEE) POC will act as a liaison between Battelle and Plattsburg Base staff. The AFCEE POC will ensure that all necessary permits are obtained and the space required to house the bioslurper field equipment is found. The following is a listing of Battelle, AFCEE, and Plattsburg Base staff who can be contacted in cases of emergency and/or required technical support during the bioslurper field initiative tests at Plattsburg AFB.

Battelle POCs	Jeff Kittel	614-424-6122
AFCEE POC	Patrick Haas	210-536-4314
Plattsburg AFB POC	Brady Baker	518-563-2871
Regulator POCs		
Air:	____________	____________
Water:	____________	____________

If you have any question, please call me at (614) 424-6122.

Sincerely,

Jeffrey A. Kittel
Program Manager
Environmental Restoration Department

JAK:gm
Attachment

cc: Ms. Sharon Money (letter only)
Ms. Petra Rosales (letter only)
Mr. Leon Sulton (letter only)

APPENDIX B

LABORATORY ANALYTICAL REPORTS

Plattsburg

AIR TOXICS LTD.

SAMPLE NAME: PAFB-V-1

ID#: 9609047-01A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

GC/PID

File Name:	**6090912**		**Date of Collection: 9/4/96**	
Dil. Factor:	**2530**		**Date of Analysis: 9/9/96**	
Compound	**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
Benzene	2.5	8.2	110	360
Toluene	2.5	9.7	530	2000
Ethyl Benzene	2.5	11	120	530
Total Xylenes	2.5	11	420	1800

TOTAL PETROLEUM HYDROCARBONS

GC/FID

(Quantitated as Jet Fuel)

File Name:	**6090912**		**Date of Collection: 9/4/96**	
Dil. Factor:	**2530**		**Date of Analysis: 9/9/96**	
Compound	**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
TPH* (C5+ Hydrocarbons)	25	160	34000	220000
C2 - C4** Hydrocarbons	25	46	1100	2000

*TPH referenced to Jet Fuel (MW=156)

**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: PAFB-V-2

ID#: 9609047-02A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

GC/PID

File Name:	**6090913**		**Date of Collection: 9/4/96**	
Dil. Factor:	**1020**		**Date of Analysis: 9/9/96**	
Compound	**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
Benzene	1.0	3.3	22	71
Toluene	1.0	3.9	200	760
Ethyl Benzene	1.0	4.5	58	260
Total Xylenes	1.0	4.5	220	970

TOTAL PETROLEUM HYDROCARBONS

GC/FID

(Quantitated as Jet Fuel)

File Name:	**6090913**		**Date of Collection: 9/4/96**	
Dil. Factor:	**1020**		**Date of Analysis: 9/9/96**	
Compound	**Det. Limit (ppmv)**	**Det. Limit (uG/L)**	**Amount (ppmv)**	**Amount (uG/L)**
TPH* (C5+ Hydrocarbons)	10	66	13000	84000
C2 - C4** Hydrocarbons	10	19	380	700

*TPH referenced to Jet Fuel (MW=156)

**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: 1 Liter Summa Canister

AIR TOXICS LTD.

SAMPLE NAME: Lab Blank

ID#: 9609047-03A

EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

GC/PID

File Name:	6090907		**Date of Collection:** NA	
Dil. Factor:	1.00		**Date of Analysis:** 9/9/96	

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected

TOTAL PETROLEUM HYDROCARBONS

GC/FID

(Quantitated as Jet Fuel)

File Name:	6090907		**Date of Collection:** NA	
Dil. Factor:	1.00		**Date of Analysis:** 9/9/96	

Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C5+ Hydrocarbons)	0.010	0.065	Not Detected	Not Detected
C2 - C4** Hydrocarbons	0.010	0.018	Not Detected	Not Detected

*TPH referenced to Jet Fuel (MW=156)

**C2 - C4 Hydrocarbons referenced to Propane (MW=44)

Container Type: NA

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

180 BLUE RAVINE ROAD, SUITE B
FOLSOM, CA 95630-4719
(916) 985-1000 FAX: (916) 985-1020

CHAIN-OF-CUSTODY RECORD

№ 008375

Page 1 of 1

Contact Person Chris Coonfare / Amanda Bush
Company Battelle
Address 505 King Ave, #10-1-59 City Columbus State OH Zip 43201
Phone (614) 424-3646 FAX (614) 424-3667
Collected By: Signature Christopher T. Coonfare

Project info:
P.O. # 91222
Project # G462201-30A0601
Project Name Plattsburgh

Turn Around Time:
☒ Normal
☐ Rush ______ Specify

Lab I.D.	Field Sample I.D.	Date & Time	Analyses Requested	Canister Pressure / Vacuum Initial	Final	Receipt
01A	PAFB-V-1	9/4/96 0830 hrs	BTEX, TPH as diesel	30" Hg	6" Hg	0" Hg
02A	PAFB-V-2	9/4/96 1045 hrs	BTEX, TPH as diesel	30" Hg	0" Hg	0.5" Hg

9/5/96

Relinquished By: (Signature) Christopher T. Coonfare Date/Time 9/4/96 1100 hrs Print Name CHRIS COONFARE
Relinquished By: (Signature) Date/Time Received By: (Signature) Date/Time
Relinquished By: (Signature) Date/Time Received By: (Signature) [signature] Date/Time 9/5/96 9:50

Notes:

Lab Use Only	Shipper Name	Air Bill #	Opened By:	Date/Time	Temp. (°C)	Condition	Custody Seals Intact?	Work Order #
	FedEx	892627823	[signature]	9/5/96 9:50	Ambient	Good	Yes No None N/A	9609047

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: (702) 355-0406
1-800-283-1183

e-mail: alpha@powernet.net
http//www.powernet.net/~alpha

Las Vegas, Nevada
(702) 498-3312
FAX: (702) 736-7523
Sacramento, California
(916) 366-9089
FAX: (916) 366-9138

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: 6462201-30A0601
Phone: (614) 424-6199
Attn: Al Pollock

Sampled: 08/30/96 Received: 09/03/96 Analyzed: 09/06-10/96

Matrix: [X] Soil [ ] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Extractable Quantitated As Diesel
BTEX - Benzene, Toluene, Ethylbenzene, Xylenes

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTEX - EPA Method 624/8240

TPH/BTXE Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit	
PLT-1 /BMI090396-01	TPH *	1,100	10	mg/Kg
	Benzene	ND	200	ug/Kg
	Toluene	ND	200	ug/Kg
	Ethylbenzene	ND	200	ug/Kg
	Total Xylenes	1,100	200	ug/Kg
PLT-2 /BMI090396-02	TPH *	1,100	10	mg/Kg
	Benzene	ND	200	ug/Kg
	Toluene	ND	200	ug/Kg
	Ethylbenzene	ND	200	ug/Kg
	Total Xylenes	1,800	200	ug/Kg

* - Components are primarily in the range of jet fuel with minor amounts in the range of light oil/motor oil.

Note: Hydrocarbons outside the range of diesel may have varying recoveries.

ND - Not Detected

Approved By: Roger L. Scholl Date: 9/13/96
Roger L. Scholl, Ph.D.
Laboratory Director

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

e-mail: alpha@powernet.net
http//www.powernet.net/~alpha

2505 Chandler Avenue, Suite 1
Las Vegas, Nevada 89120
(702) 498-3312
FAX: 702-736-7523
1-800-283-1183

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: G462201-30A0601
Phone: (614) 424-6199
Attn: Chris Coonfare

Sampled: 09/04/96 Received: 09/05/96 Analyzed: 09/10/96

Matrix: [ ] Soil [ ] Water [X] Waste

Analysis Requested: BTEX - Benzene,Toluene,Ethylbenzene,Xylenes

Methodology: BTEX - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit
PAFB-F /BMI090596-01	Benzene	ND	950 mg/Kg
	Toluene	1,700	950 mg/Kg
	Ethylbenzene	1,500	950 mg/Kg
	Total Xylenes	11,000	950 mg/Kg

ND - Not Detected

Approved by: Walter Hinchman Date: 9/11/96
Walter Hinchman
Quality Assurance Officer

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
(702) 355-1044
FAX: 702-355-0406
1-800-283-1183

e-mail: alpha@powernet.net
http//www.powernet.net/~alpha

2505 Chandler Avenue, Suite 1
Las Vegas, Nevada 89120
(702) 498-3312
FAX: 702-736-7523
1-800-283-1183

ANALYTICAL REPORT

Battelle
505 King Ave
Columbus Ohio 43201

Job#: G462201-30A0601
Phone: (614) 424-6199
Attn: Chris Coonfare

Sampled: 09/04/96 Received: 09/05/96 Analyzed: 09/10/96

Matrix: [ ] Soil [X] Water [ ] Waste

Analysis Requested: TPH - Total Petroleum Hydrocarbons-Purgeable Quantitated As Gasoline
BTEX - Benzene,Toluene,Ethylbenzene,Xylenes

Methodology: TPH - Modified 8015/DHS LUFT Manual/BLS-191
BTEX - Method 624/8240

Results:

Client ID/ Lab ID	Parameter	Concentration	Detection Limit	
PAFB-W1	TPH (Purgeable)	44	5.0	mg/L
/BMI090596-02	Benzene	680	10	ug/L
	Toluene	3,500	10	ug/L
	Ethylbenzene	810	10	ug/L
	Total Xylenes	5,500	10	ug/L

ND - Not Detected

Approved by: Walter Hinchman Date: 9/11/96
Walter Hinchman
Quality Assurance Officer

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. ______

Proj. No. G462201-30A0601

Project Title Plattsburgh AFB Bioslurper Pilot Test

SAMPLERS: (Signature) Christopher T. Coonfare

DATE	TIME	SAMPLE I.D.	BTEX EPA Mod. 8020	BTEX EPA 602	TPH Purg. Mod 8015/5030	Container No.	Number of Containers	Remarks
9/4/96	1340	PAFB- F	✓				1	LNAPL
9/4/96	1415	PAFB- W1		✓	✓		3	Aqueous

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Christopher T. Coonfare	9/4/96 1435	Matthew T. Souza			

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks
				VoA vials, Aqueous samples preserved w/ HCl

Page 1 of 1

Billing Information:

Name
Address
City, State, Zip
Phone Number Fax

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
Phone (702) 355-1044
Fax (702) 355-0406

Page # 1 of 1

Client Name: Battelle
P.O. #: G462201-30
Job #: 0A0601
Address:
PWS #:
DWR #:
City, State, Zip:
Phone #:
Fax #:
Sampled by:
Report Attention:

Analyses Required

Time Sampled	Date Sampled	Matrix* See Key Below	Office Use Only Lab ID Number	Sample Description	Total and type of containers ** See below	BTXE/8020	BTXE/1602	TPHG									
	9-4	OT	BM1090596-01	PAFB-F	1 Tin Can	X											
	✓	AQ	02	PAFB-W1	3V		X	X									

REMARKS:

Plattsburg AFB
Bioslurper Pilot Test

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by	Katherine Souza	K Souza	AAI	9-5-96	1200
Relinquished by					
Received by					
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

Laboratory Analysis Report

Sierra Environmental Monitoring, Inc.

ALPHA ANALYTICAL
255 GLENDALE AVENUE, SUITE 21
SPARKS NV 89431

Date : 9/09/96
Client : ALP-855
Taken by: CLIENT
Report : 17352
PO# :

Sample	Collected Date	Collected Time	DENSITY G/CM3	PARTICLE SIZE DISTISUTION FRACTION %	POROSITY			
BMI090396-01 - PLT-1	8/30/96	:	1.53	REPORT	42.3			
BMI090396-02 - PLT-2	8/30/96	:	1.79	REPORT	32.5			

pproved By:

This report is applicable only to the sample received by the laboratory. The liability of the laboratory is limited to the amount paid for this report. This report is for the exclusive use of the client to whom it is addressed and upon the condition that the client ssumes all liability for the further distribution of the report or its contents.

Villiam F. Pillsbury
resident

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Sierra
Environmental
Monitoring, Inc.

September 9, 1996

TO: **Alpha Analytical**

FROM: Sierra Environmental Monitoring, Inc.

RE: Particle Size Distribution Analysis for Samples:

SEM 9609-0065 BMI 090396-01-PLT-1
SEM 9609-0066 BMI 090396-02-PLT-2

As per your request, we have performed particle size analysis on the samples submitted to our laboratory. Test results are as follows:

9609-0065	**Clay: 0.0 %**	**Silt: 1.6 %**	**Sand: 98.4 %**
9609-0066	**Clay: 0.0 %**	**Silt: 1.0 %**	**Sand: 99.0 %**

The samples were passed through a #10 sieve prior to analysis as per procedure. All results are based on oven dry sample weights.

We appreciate this opportunity to provide our laboratory testing services. If you have any questions or require further testing, please feel free to contact us at your convenience.

Sincerely,
SIERRA ENVIRONMENTAL MONITORING, INC.

John Seher
Laboratory Manager

William F. Pillsbury
President

1135 Financial Blvd.
Reno, NV 89502
Phone (702) 857-2400
FAX (702) 857-2404

John C. Seher
Manager

Battelle
Columbus Laboratories

CHAIN OF CUSTODY RECORD

Form No. ______

Proj. No. 6462201-30A0601

Project Title Plattsburgh AFB Bioslurper Pilot Test

SAMPLERS: (Signature) Christopher T. Coonfare

DATE	TIME	SAMPLE I.D.	TPH as diesel	BTEX	Porosity	Bulk Density	Particle Size	Container No.	Number of Containers	Remarks
8/30/96	1540	PLT-1	✓	✓	✓	✓	✓	PLT 1	1	Soil
8/30/96	1545	PLT-2	✓	✓	✓	✓	✓	PLT 2	1	Soil

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Christopher T. Coonfare	8/30/96 1815	Katherine Sugar			

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)

Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks
				Packed in Cooler w/ blue ice.

Page 1 of 1

Alpha Analytical, Inc.
255 Glendale Avenue, Suite 21
Sparks, Nevada 89431
Phone (702) 355-1044
Fax (702) 355-0406

Billing Information:

Name
Address
City, State, Zip
Phone Number Fax

Client Name: Battelle	P.O.# 6462201-3	Job # DA0601	
Address	PWS #	DWR #	
City, State, Zip	Phone #	Fax #	

Sampled by:
Report Attention:

Analyses Required

Time Sampled	Date Sampled	Matrix* See Key Below	Office Use Only Lab ID Number	Sample Description	Total and type of containers ** See below	TPH-D	BTXE	Porosity	Bulkdensity	Particlesize							
	8/30	SO	BM1080396-01	PLT-1	1B	X	X	X	X	X							
	✓	✓	02	PLT-2	1B	X	X	X	X	X							

REMARKS:

Plattsburgh AFB
Bioslurper pilot test

some sample taken out for
TPH & BTXE analyses.

	Signature	Print Name	Company	Date	Time
Relinquished by					
Received by	[signature]	K2 Souza	AAI	9-3-96	1000
Relinquished by	[signature]	Craig Giesy	AAI	9/3/96	1350
Received by	[signature]	L. Ansert	SEM, Inc.	9/3/96	1350
Relinquished by					
Received by					

NOTE: Samples are discarded 60 days after results are reported unless other arrangements are made. Hazardous samples will be returned to client or disposed of at client expense.

*Key: AQ - Aqueous SO - Soil WA - Waste OT - Other **: L-Liter V-Voa S-Soil Jar O-Orbo T-Tedlar B-Brass P-Plastic OT-Other

APPENDIX C

SYSTEM CHECKLIST

Checklist for System Shakedown

Site: Plattsburgh

Date: 8.28.96

Operator's Initials: ____

Equipment	Check if OK	Comments
Liquid Ring Pump	✓	
Aqueous Effluent Transfer Pump	✓	
Oil/Water Separator	✓	
Vapor Flow Meter	✓	
Fuel Flow Meter	✓	
Water Flow Meter	✓	
Emergency Shut Off float Switch Effluent Transfer Tank	✓	
Analytical Field Instrumentation GasTechtor O_2/CO_2 Analyzer TraceTechtor Hydrocarbon Analyzer Oil/Water Interface Probe Magnehelic Boards Thermocouple Thermometer	 ✓ ✓ ✓ ✓ ✓	

APPENDIX D

DATA SHEETS FROM THE SHORT-TERM PILOT TEST

ATMOSPHERIC OBSERVATIONS

Site: Plattsburgh AFB   Operators: Coonfare / Woolfe

Date/Time	Ambient Temperature	Relative Humidity	Barometric Pressure
8/29/96 1410	87° F		
8/29/96 1610	74		
8/29/96 1735	76		
8/29/96 2025	69		
Skimmer 8/30/96 0800	60		
8/30/96 1200	77		
8/30/96 1915	66		
8/31/96 0955	79		
8/31/96 1225	82		
8/31/96 1510	78		
8/31/96 1915	68.2		
9/1/96 0630	55.6	98%	
Bioslurper 9/1/96 0930	71.5	98%	
9/1/96 1330	79	28%	
9/1/96 1830	72.4	53%	
9/1/96 2100	67.8		
9/2/96 0700	62	91%	
9/2/96 1200	78	91	
9/2/96 1930	73	91	

ATMOSPHERIC OBSERVATIONS

Site: Plattsburgh AFB

Operators: Coonfare / Wooife

Date/Time	Ambient Temperature	Relative Humidity	Barometric Pressure
9/3/96 0730	64°F	98%	
9/3/96 1600	84		
9/3/96 1930	72		
9/4/96 0800	71		
9/4/96 1515	83		
9/4/96 1715	83		
9/4/96 1915	78		
9/5/96 0730	66		
9/5/96 1200	83		
9/5/96 1600	85		
9/5/96 2040	72		
9/6/96 0740	66		
9/6/96 1200	87		

Bioslurper

Skimmer

Drawdown

Baildown Test Record Sheet

Site: PLATTSBURGH AFB

Well Identification: Extraction Well approx 15 ft south of bioslurper well MW-108 (in concrete manhole)

Well Diameter (OD/ID): 6 inch

Date at Start of Test: 8/26/96 Sampler's Initials: CC

Time at Start of Test: 1650

Initial Readings

Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)	Total Volume Bailed (L)
40.32	39.78	.54	1.1

Test Data

Sample Collection Time	Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)
0 min	40.30	39.96	.34
30	40.24	39.92	.32
33	40.20	39.88	.32
35	40.20	39.88	.32
44	40.20	39.84	.36
68	40.18	39.83	.35
937	40.32	39.83	.47

Figure 9. Typical Baildown Test Record Sheet

Baildown Test Record Sheet

Site: PLATTSBURGH AFB

Well Identification: MW-108

Well Diameter (OD/ID): 2 inch sch 40 PVC

Date at Start of Test: 8/26/96

Sampler's Initials: CC

Time at Start of Test: 1519 hrs

Initial Readings

Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)	Total Volume Bailed (L)
41.77 ft	41.04 ft	.73 ft	1.4 L

Test Data

Sample Collection Time	Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)
0 min	41.30	41.06	.24
0.5	41.40	41.06	.34
1	41.35	41.06	.29
1.5	41.43	41.06	.37
5	41.40	41.05	.35
6	41.40	41.04	.36
7	41.40	41.04	.36
9	41.40	41.04	.36
11	41.41	41.03	.38
13	41.46	41.04	.42
15	41.46	41.05	.41
19	41.53	41.07	.46

Figure 9. Typical Baildown Test Record Sheet

Baildown Test Record Sheet

Site: PLATTSBURGH AFB

Well Identification: MW-108

Well Diameter (OD/ID): 2 inch sch 40 PVC

Date at Start of Test: 8/26/96

Sampler's Initials: CC

Time at Start of Test: 1579 hrs

Initial Readings

Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)	Total Volume Bailed (L)
41.77 ft	41.04 ft	.73 ft	1.4 L

Test Data

Sample Collection Time	Depth to Groundwater (ft)	Depth to LNAPL (ft)	LNAPL Thickness (ft)
23 min	41.56	41.08	.48
32	41.59	41.08	.51
41	41.63	41.08	.55
62	41.69	41.09	.60
76	41.71	41.09	.62
123	41.77	41.09	.68
159	41.79	41.08	.71
1031	41.85	41.10	.75

Figure 9. Typical Baildown Test Record Sheet

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page ____ of ____

Site: PLATTSBURGH AFB

Operators: COONFARE / WOOLFE

Test Type: INITIAL SKIMMER

Depth to Groundwater: 42.64 Depth to Fuel: 42.07

Start Date: 8/29/96

Start Time: 1200 hrs

Well ID: MW-108

Depth of Tube: 42.6

Date/Time	Run Time	Vapor Extraction			Pump ~~Stack~~ H_2O Temp (°C)	Pump ~~Head~~ Vacuum (in. Hg)	Extraction Well Vacuum (in. H_2O)	Drop Tube Vac (in. Hg)
		Stack Pressure (in. H_2O)	Stack Temp (°C) ~~Carbon Drums (in. H_2O)~~	Flowrate (scfm)				
8/29 1210	10 min	.12		37	28.2	22	0	9
8/29 1410	2 hr 10 min	error	35.4		33.1	22	0	8
8/29 1735	5 hr 15 min	.12	32.2	37	31.9	22	0	8
8/29 2025		.25	32.2	56	31.1	21	0	8
8/30 0800		.25	33.9	56	35.2	22	0	7
8/30 1200		.15	37.3	43	37.7	22	0	8
8/30 1915		.25	35.5	56	37.1	22	0	8
8/31 0955		.13	35.1	39	36.0	22	0	8
8/31 1225		.09	37.9	33	38.4	22	0	8

Figure 11. Typical Record Sheets for Bioslurper Pilot Testing (Continued)

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page ____ of ____

Site: PLATTSBURGH AFB

Operators: COONFARE / WOOLFE

Test Type: BIOSLURPER

Depth to Groundwater: 41.72 Depth to Fuel: 41.5

Start Date: 8/31/96

Start Time: 1445

Well ID: MW-108

Depth of Tube: 41.7

Date/Time	Run Time	Vapor Extraction			Pump ~~Stack~~ H_2O Temp (°C)	Pump ~~Head~~ Vacuum (in. Hg)	Extraction Well Vacuum (in. H_2O)	Drop Tube Vac (in. Hg)
		Stack Pressure (in. H_2O)	Stack Temp (°C) ~~Carbon Drums (in. H_2O)~~	Flowrate (scfm)				
8/31 1510	25 min		30.3		29.2	24	10	12
8/31 1915	4 hr 30 min	.24	24.2	55	24.9	24	10	11
9/1 0630	15 hr 45 min	.25	22.3	56	23.6	24	11	11
9/1 0930	18 hr 45 min	.17	25.1 cc ~~24.9~~	45	24.5 cc ~~25.0~~	24	11	12
9/1 1330	22 hr 45 min	.19	28.6	50	26.1	24	12	12
9/1 1830	27 hr 45 min	.25	24.9	56	25.0	24	11	12
9/1 2100	30 hr 15 min	.26	25.2	57	26.3	24	11	12
9/2 0700	40 hr 15 min	.245	26.4	55	25.1	25	10	10
9/2 1200	45 hr 15 min	.185	29.2	47	28.5	24	10	10
9/2 1930	52 hr 45 min	.26	27.0	57	27.8	24	10	10
9/3 0730	64 hr 45 min	.24	25.5	55	26.8	24	10	10
9/3 1600	73 hr 15 min	.22	30.4	53	28.7	24	10	10
9/3 1930	76 hr 45 min	.26	26.0	57	27.0	24	9	11
9/4 0800	89 hr 15 min	.23	26.6	55	26.5	24	10	12
9/4 1515	96 hr 30 min	.21	29.4	52	29.1	24		11

Figure 11. Typical Record Sheets for Bioslurper Pilot Testing (Continued)

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page ____ of ____

Site: PLATTSBURGH AFB

Operators: COONFARE / WOOLFE

Test Type: 2nd SKIMMER

Depth to Groundwater: 41.72 Depth to Fuel: 41.5

Start Date: 9/4/96

Start Time: 1710

Well ID: MW-108

Depth of Tube: 41.7

Date/Time	Run Time	Vapor Extraction			Pump ~~Stack~~ H_2O Temp (°C)	Pump ~~Head~~ Vacuum (in. Hg)	Extraction Well Vacuum (in. H_2O)	Drop Tube Vac (in. Hg)
		Stack Pressure (in. H_2O)	Stack Temp (°C) ~~Carbon Drums~~ ~~(in. H_2O)~~	Flowrate (scfm)				
9/4 1715	5 min	.19	32.7	50	31.0	23	0	7
9/4 1915	2 hr 5 min	.20	42.8	51	44.2	21	0	7
9/5 0730	14 hr 20 min	.17	42.7	45	44.4	22	0	7
9/5 1200	18 hr 50 min	.14	45.1	42	46.4	22	0	7

Figure 11. Typical Record Sheets for Bioslurper Pilot Testing (Continued)

Bioslurping Pilot Test
(Data Sheet 2)
Pilot Test Pumping Data

Page ___ of ___

Site: PLATTSBURGH AFB

Operators: COONFARE / WOOLFE

Test Type: DRAWDOWN

Depth to Groundwater: 42.06 Depth to Fuel: 42.02

Start Date: 9/5/96

Start Time: 1300

Well ID: MW-108

Depth of Tube: 43.5

Date/Time	Run Time	Vapor Extraction			Pump ~~Stack~~ H_2O Temp (°C)	Pump ~~Head~~ Vacuum (in. Hg)	Extraction Well Vacuum (in. H_2O)	Drop Tube Vac (in. Hg)
		Stack Pressure (in. H_2O)	Stack Temp (°C) ~~Carbon Drums (in. H_2O)~~	Flowrate (scfm)				
9/5 1600	3 hr	.22	31.2	53	30.4	24	0	10
9/5 2040	7 hr 40 min	.28	29.2	58	30.6	24	0	10
9/6 0740	18 hr 40 min	.24	29.6	55	31.4	24	0	10
9/6 1200	23 hr		33.4		33.0	24	0	10

Figure 11. Typical Record Sheets for Bioslurper Pilot Testing (Continued)

APPENDIX E

SOIL GAS PERMEABILITY TEST RESULTS

BATTELLE	RECORD SHEET FOR AIR PERMEABILITY TEST				DATE/TIME: 8/31/96 1445
DISTANCE FROM VENT WELL (ft. & tenths)	19.5 ft	19.5 ft	19.5 ft		SITE: PLATTSBURGH AFB
TIME FROM START-UP (MIN.)	PT. CODE	PT. CODE	PT. CODE	PT. CODE	RECORDED BY: COONFARE
	BAT-1 12.0' ft	BAT-1 18.5 ft	BAT-1 25.5 ft		COMMENTS
	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	
0	0	0	0		
0.5	0	0	0		
1	.02	.03	.05		
2	.01	.04	.05		
3	.01	.03	.05		
4	.01	.03	.06		
5	.02	.05	.06		
8	.02	.06	.06		
10	.02	.06	.07		
15	.03	.07	.08		
30	.03	.07	.10		
255	.03	.09	.10		
315	.03	.09	.11		
1005	.03	.09	.10		

BATTELLE	RECORD SHEET FOR AIR PERMEABILITY TEST				DATE/TIME: 8/31/96 1445
DISTANCE FROM VENT WELL (ft. & tenths)	19.5 ft	19.5 ft	19.5 ft		SITE: PLATTSBURGH AFB
TIME FROM START-UP (MIN.)	PT. CODE	PT. CODE	PT. CODE	PT. CODE	RECORDED BY: COONFARE
	BAT-1 12.0 ft	BAT-1 19.5 ft	BAT-1 25.5 ft		COMMENTS
	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	
1125	.03	.08	.09		
1365	.03	.09	.10		
1665	.03	.065	.07		
2445	.02	.065	.07		
3165	.02	.05	.06		
4415	.02	.05	.05		
5505	.01	.05	.06		

BATTELLE	RECORD SHEET FOR AIR PERMEABILITY TEST				DATE/TIME: 8/31/96 1445
DISTANCE FROM VENT WELL (ft. & tenths)	37.7 ft	37.7 ft	37.7 ft		SITE: PLATTSBURGH AFB
TIME FROM START-UP (MIN.)	PT. CODE	PT. CODE	PT. CODE	PT. CODE	RECORDED BY: COONFARE
	MPA 12.0 ft	MPA 24.0 ft	MPA 39.0 ft		COMMENTS
	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	
0	0	0	0		
0.5	0	0	0		
1	.03	.04	.07		
2	.04	.06	.12		
3	.04	.06	.14		
4	.04	.08	.15		
5	.04	.08	.16		
8	.03	.08	.17		
10	.04	.08	.17		
15	.04	.09	.17		
30	.04	.09	.19		
255	.02	.07	.16		
315	.02	.11	.17		
1005	.05	.10	.20		

BATTELLE	RECORD SHEET FOR AIR PERMEABILITY TEST				DATE/TIME: 8/31/96 1445
DISTANCE FROM VENT WELL (ft. & tenths)	37.7 ft	37.7 ft	37.7 ft		SITE: PLATTSBURGH AFB
TIME FROM START-UP (MIN.)	PT. CODE	PT. CODE	PT. CODE	PT. CODE	RECORDED BY: COONFARE
	MPA 12.0 ft	MPA 24.0 ft	MPA 39.0 ft		COMMENTS
	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	
1125	.05	.12	.21		
1365	.06	.12	.22		
1665	.04	.10	.19		
2445	.04	.10	.185		
3165	.03	.08	.15		
4415	.03	.08	.15		
5505	.02	.07	.14		

BATTELLE	RECORD SHEET FOR AIR PERMEABILITY TEST				DATE/TIME: 8/31/96 1445
DISTANCE FROM VENT WELL (ft. & tenths)	49.8 ft	49.8 ft	49.8 ft		SITE: PLATTSBURGH AFB
TIME FROM START-UP (MIN.)	PT. CODE	PT. CODE	PT. CODE	PT. CODE	RECORDED BY: COONFARE
	MPB 12.0 ft	MPB 26.0 ft	MPB 39.0 ft		COMMENTS
	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	
0	0	0	0		
0.5	0	0	0		
1	.02	.03	.04		
2	.03	.05	.07		
3	.03	.05	.09		
4	.03	.07	.09		
5	.03	.08	.11		
8	.03	.07	.10		
10	.03	.07	.11		
15	.03	.07	.11		
30	.03	.08	.13		
255	.04	.10	.155		
315	.04	.11	.16		
1005	.04	.10	.16		

BATTELLE	RECORD SHEET FOR AIR PERMEABILITY TEST				DATE/TIME: 8/31/96 1445
DISTANCE FROM VENT WELL (ft. & tenths)	49.8 ft	49.8 ft	49.8 ft		SITE: PLATTSBURGH AFB
TIME FROM START-UP (MIN.)	PT. CODE	PT. CODE	PT. CODE	PT. CODE	RECORDED BY: COONFARE
	MPB 12.0 ft	MPB 26.0 ft	MPB 39.0 ft		COMMENTS
	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	PRESSURE (IN H_2O)	
1125	.04	.09	.14		
1365	.045	.12	.16		
1665	.03	.07	.11		
2445	.03	.08	.13		
3165	.03	.06	.10		
4415	.03	.07	.09		
5505	.02	.06	.09		

APPENDIX F

IN SITU RESPIRATION TEST RESULTS

Record Sheet for In Situ Respiration Test

Site PLATTSBURGH AFB	Monitoring Point BAT-1 18.5 ft	
Shutdown Date 9/6/96	O_2/CO_2 Meter No.	TPH Meter No.
Shutdown Time 0850 hrs	Recorded by COONFARE	

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
9/6/96	0855	21.	0.5	200	1.5		
9/6/96	0920	19.9	0	0	4.7		
9/6/96	1120	19.6	0.25	0	4.3		
9/6/96	1330	19.1	0.5	0	2.9		
9/6/96	1545	18.4	1	0	1.6		
9/6/96	1900	18.7	1	0	.91		
9/6/96	2300	13.1	3.5	20	1.4		
9/7/96	0330	10.2	5.5	0	.84		
9/7/96	0730	4.6	8	0	.62		
~~9/7/96~~	~~1145~~						

Record Sheet for In Situ Respiration Test

Site PLATTSBURGH AFB	Monitoring Point MPA 12.0 Ft
Shutdown Date 9/6/96	O_2/CO_2 Meter No. / TPH Meter No.
Shutdown Time 0850 hrs	Recorded by COONFARE

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
9/6/96	0855	20.4	0.25	0	1.4		
9/6/96	0920	20.2	0.25	60	3.7		
9/6/96	1120	18.8	2	0	1.5		
9/6/96	1330	14.9	1.2	0	2.3		
9/6/96	1545	14.7	3	0	.58		
9/6/96	1900	12.1	5	260	.48		
9/6/96	2300	12.9	7	340	.40		
9/7/96	0330	11.8	9	420	.11		
9/7/96	0730	3.0	14	120	.07		TPH w/ 10:1 diluter

Record Sheet for In Situ Respiration Test

Site PLATTSBURGH AFB	Monitoring Point MPA 39.0ft
Shutdown Date 9/6/96	O_2/CO_2 Meter No.	TPH Meter No.
Shutdown Time 0850	Recorded by COONFARE

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
9/6/96	0855	20.2	0	0	2.5		
9/6/96	0920	20.1 cc	0. cc	20 cc	4.7 cc		
9/6/96	1120	19.9	0	0	4.0		
9/6/96	1330	19.6	0.2	120	2.4		
9/6/96	1545	19.6	0	140	1.9		
9/6/96	1900	16.8	1.2	440	1.6		
9/6/96	2300	14.9	3	480	1.2		
9/7/96	0330	11.7	5	680	.82		
9/7/96	0730	7.7	7.5	60 *	.60		* with 10:1 reducer → 10X
9/7/96	1145	2.3	13	100 *	.03		* with 10:1 reducer → 10X

INSITU.RS (G462201-1001 DISK)

Record Sheet for In Situ Respiration Test

Site PLATTSBURGH AFB	Monitoring Point MPB 26.0 ft
Shutdown Date 9/6/96	O_2/CO_2 Meter No. / TPH Meter No.
Shutdown Time 0850	Recorded by COONFARE

Date	Time	O_2 (%)	CO_2 (%)	TPH (ppm)	He (%)	Temperature (°C)	Comments
9/6/96	0855	20.2	0	0	2.7		
9/6/96	0920	20.2	0	0	4.9		
9/6/96	1120	19.9	0	60	4.2		
9/6/96	1330	19.7	0.2	60	1.3		
9/6/96	1545	19.5	0.5	200	3.6		
9/6/96	1900	19.0	0.5	360	3.9		
9/6/96	2300	18.6	0.5	280	3.6		
9/7/96	0330	16.5	1.5	460	3.0		
9/7/96	0730	17.7	1.5	120	.81		
9/7/96	1145	10.8	4	900	.01		